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INDEX TO VOLUME LXXVII

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Subdivided into GENERAL (including AUTHORS,) ENGINEERING LITERATURE AND CONTRACT PRICES

Explanatory Note

This index follows, generally, the methods adopted and more fully explained with the index for Volume 71. An asterisk (*) indicates an illustrated article, and (n), (ns), note, notes, chiefly used for fine-print ones. An editorial referring to an article may be indexed simply by appending the page number.

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Engineering News

VOLUME 77 JANUARY 4, 1917 NUMBER 1

Hudson River Road Built on Mountain Side

By Eugene Geduldiger*

An important link has been added to Route No. 3 of the New York State highway system by the completion of the Nyack-Rockland Lake road, the work on which was described in *Engineering News,* Nov. 25, 1915. This is on the main thoroughfare between New York and Albany along the west shore of the Hudson River, and passes through the River divisions of the Palisades Interstate Park, including the ever growing popular playground at Bear Mountain. The Nyack-Rockland Lake road begins at Main St. in the village of Nyack, Rockland County, and runs north along Midland Ave., then west and northwest over Hook Mountain to the southern end of Rockland Lake, a distance of 2.95 mi. It is a characteristic mountain road in that it has many turns and changing grades. The maximum grade is 9%, but this is only for a short distance, near Sta. 110. The most interesting section of the road is between Sta. 95 and 112, where the new line follows up along the rocky slopes of Hook Mountain, locally known as Goat Hill (see Figs. 1 and 2). This new line eliminates a "hair-pin" turn at Sta. 113+50 of the main line, which was very dangerous because it occurred on a heavy grade where it is impossible for a modern large automobile to turn without backing.

FIG. 1. NYACK-ROCKLAND LAKE ROAD; NEW LOCATION AT STA. 112

When the improvement of the road was first considered, the intention was to follow the old alignment, widening and building some kind of plateau to ease this turn. At that time it was considered impossible and impracticable to locate a highway along the dangerous side hill of talus, owing to the excessive cost of construction. After careful investigation, however, it was found that such a line would be possible and practicable.

A comparative estimate showed that the cost of locating the line along the mountain would not be excessive, and that this relocation would be nearly 500 ft. shorter than the old road besides eliminating the "hair-pin" turn. The additional cost of about $4,500 was considered small in comparison with the benefit derived. The new line begins to ascend the mountain side at Sta. 95 with a slight curve to the west and rises on an average of 8% with easy curves to Sta. 111 and Sta. 112, where, with a moderately sharp curve, it passes through a 20-ft. rock cut and meets the old location. The greater part of the location runs through a nest of trap-rock boulders that vary in size from ½ cu.ft. to 1½ cu.yd. Underlying this talus is a thin layer of earth covering a rock ledge of steep inclination. From Sta. 105+50 to Sta. 111+50 a dry wall was built on the east side of the road. This wall varies in height from 5 to 35 ft., with a base width of nearly 50% of the height.

The upper 18 in. of the wall is laid in cement mortar to afford a foundation for an 18 in. (wide) by 3 ft. 6 in. (high) wet-masonry parapet wall finished with a 6-in. rustic coping. The foundation of the wall was carried down to the rock ledge, which in some places was nearly 6 ft. below the original surface. The rock ledge was benched in order to give the wall a secure footing. The greatest part of the fill was laid in courses of rock, thereby relieving the wall of excessive pressure. From Sta. 110+50 to Sta. 111+50 on the uphill side of the road an old dry-masonry wall was replaced by a wet-masonry wall, which was given considerable batter

*Assistant Engineer in charge of Rockland County, Poughkeepsie, N. Y.

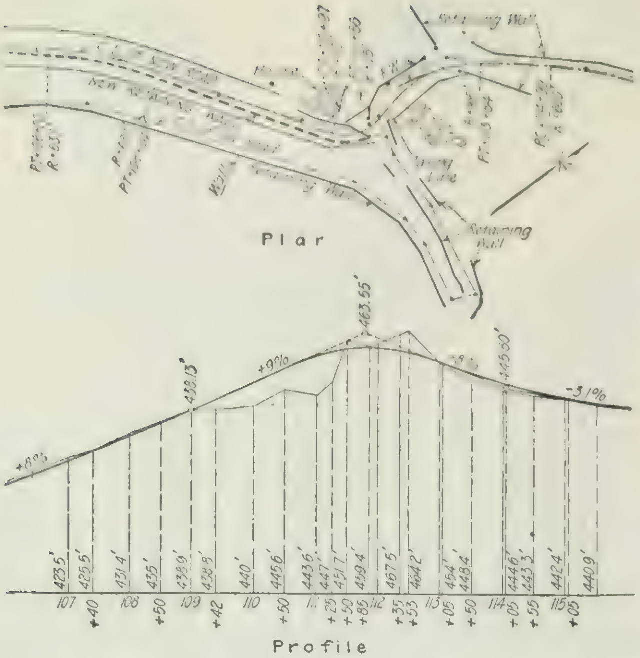


FIG. 2. PLAN OF RELOCATION OF NYACK-ROCKLAND LAKE ROAD AT STA. 112

on its front face in order to retain a good line of sight around the curve ahead.

The construction of the remaining portion of the road did not meet with any considerable difficulty. The typical construction is a 16-ft. macadam pavement on a 32-ft. roadway, narrowing to 24 ft. along the side-hill line. The foundation consists of an 8-in. course of field stone, laid on edge and filled with crusher run. Over the foundation is a 2-in. course of No. 4 (3½-in.) crushed stone filled with crusher dust. (Where unstable places occurred in the subgrade, the foundation course was increased to 12 in. in thickness and in several instances to 20 in.) Where the roadbed is in rock, the bottom course consists of a course of broken-stone macadam 4 in. thick. On the foundation a 3-in. bituminous top course (penetration method) was placed, using a tar binder.

FIG. 3. LOOKING NORTH TOWARD CURVE AT STA. 112 OF NYACK-ROCKLAND ROAD

FIG. 4. LOOKING NORTH THROUGH ROCK CUT AT STA. 112

The binder selected for this road was "Tarvia X," spread at the rate of 2¼ gal. per sq.yd. in two pourings of 1½ and ¾ gal. per sq.yd. each. It was delivered to the road in motor trucks owned and operated by the Barrett Manufacturing Co. It was applied at a temperature of 300° F. under a pressure of from 40 to 60 lb. per sq.in.

The stone was obtained and crushed along the road by the contractor, using boulders from the hillside of talus, which was of an excellent quality trap rock. All structures were built according to the standards of the New York State Highway Department. Culverts were constructed of concrete with reinforced flat-slab tops. All earth ditches occurring on grades of 5% or over were paved with cobble gutters. On grades exceeding 7% the paving was laid in cement mortar.

The table shown on the next page gives the approximate quantities and unit prices of the contract.

B. H. Wait is division engineer for the State Highway Department. The contractors were Brady-Oltarsh Construction Co. of New York, William J. Kelly, superintendent. The writer had charge of the survey, preparing

of plans and supervising of construction. Livingston Leeds, assistant engineer, had immediate charge of construction.

COST OF NYACK-ROCKLAND LAKE ROAD

Clearing and grubbing	$200.00
12,500 cu.yd. earth excavation at	.40
4,800 cu.yd. rock excavation at	1.50
100 cu.yd. overhaul at	.01
12 tons of cast-iron pipe at	33.00
35 cu.yd. of riprap at	2.00
30 cu.yd. second-class concrete at	6.00
120 cu.yd. third-class concrete at	6.00
220 cu.yd. stone masonry at	4.00
1,500 sq.yd. cobble gutters at	.50
810 lb. metal reinforcement at	.05
116 lb. miscellaneous iron at	.05
2,600 lin.ft. wooden guard railing at	.23
9 guide signs at	2.00
2 highway number signs at	2.00
2 danger signs at	2.00
5 concrete sign posts at	10.00
120 cu.yd. broken stone, loose measure, No. 1 and No. 2 size at	1.50
3,800 cu.yd. foundation-course field or quarry stone at	1.45
1,775 cu.yd. bottom-course broken stone at	2.50
3,440 sq.yd. cleaning old pavement at	.004
2,050 cu.yd. top-course bituminous macadam, penetration method, at	2.75
1,932 lin.ft. restoring shoulders at	.02
1,250 cu.yd. stone masonry laid dry in place, complete, at	2.00
55,800 gal. bituminous binder at	.09
1,717 gal. bituminous binder, hot application at	.12
Approximate total cost of road	39,662.74
Approximate cost per mi	13,480.10

Heat Loss Through Various Types of Window Sash*

In the industrial plant of today, where so much emphasis is placed upon maximum daylight, the exterior wall surface consists principally of windows, and the heat loss through them is a very important matter. A series of tests was made by W. S. Brown under the direction of Arthur N. Sheldon to determine the relative heat loss through various types of wood, steel and hollow-metal sash with single and double glazing.

The apparatus was an air-tight box one side of which was closed by the sash to be tested. An electric heater in the bottom of the test box maintained the desired temperature difference between inside and outside air. The loss of heat was computed from wattmeter readings, and a quantity H—the B.t.u. transmitted per 24 hr. per sq.ft. of exposed surface per degree difference in temperature—was determined for each sash. Tests were made at approximately 40° and 70° F. temperature difference under conditions closely imitating actual practice. Circulation of air over the surface of the sash to be tested was provided by two 12-in. fans placed one above the other 4 ft. from the vertical center-line of the sash. The humidity of the air inside the test box was kept as constant as possible throughout the series of tests by means of water-saturated felt and was measured by a wet- and dry-bulb hygrometer. The humidity remained constant during the period of each individual test.

A résumé of the comparative heat-transmission rate is given in Tables 1 and 2. The tests showed that for a given temperature difference the solid-steel sash bars were hotter than the wooden bars and by their greater conductivity constituted a direct path for the transmission of heat to the outside air. The hollow-metal sash bars were cooler than the solid-steel, but warmer than the wood.

Condensation appeared on the single-glazed sash when its temperature was low enough to cool below the dew point the air confined within the test box. The moisture was evidently on the inside of the panes. Where condensation occurred in the air space, in double-glazed sash, the moisture was always on the outside pane of glass, which of course, was the cooler one.

The wood sash showed no internal condensation, but in the two steel sash condensation was very marked and was evident in the hollow-metal sample. This condition was investigated in the steel sash, with a ¾-in. air space.

Holes were bored through each of several of the outer panes of wire glass, smoke was blown into the air spaces, and leaks to the outside or to adjacent air spaces were carefully noted. Leakage was found to be quite general. It was observed that in lights where condensation was evident the greatest leakage was into the interior of the box, and that in those lights where no condensation appeared the greatest leakage was to the air outside the box. Following this clue the entire sash was reglazed, and holes were bored in seven of the outer panes and in five of the inner panes, free communication being thus established either to the external cool air or to the warmer air inside. It was now observed that (a) lights in which the air space opened to the outside or cooler air only, showed no condensation; (b) lights in which the air space opened to the warm air inside the test box showed much condensation.

TABLE 1. HEAT-TRANSMISSION RATES AT APPROXIMATELY 40° F. TEMPERATURE DIFFERENCE

Sample	Actual Heat Head, Deg. F.	H Computed at Actual Heat Head	H Corrected to 40° F. Heat Head	Relative Humidity	Condensation
1. Single-glazed solid steel	44.5	29.3	28.5	36	None
2. Double-glazed solid steel—¾-in. air space	37.4	20.4	20.5	34	None
3. Double-glazed solid steel—3/16-in. air space	45.7	22.8	22.5	43	Very slight on air-space side of one outside pane and box side of one inside pane
4. Double-glazed wood—⅝-in. air space	47.3	14.2	13.9	49	None
5. Single-glazed wood	41.2	25.6	25.5	44	Hardly noticeable
6. Double-glazed hollow metal—¾-in. air space	43.9	15.4	15.2	54	On air-space side of one outside pane
7. Single-glazed hollow metal	46.0	27.1	26.4	43	All

TABLE 2. HEAT-TRANSMISSION RATES AT APPROXIMATELY 70° F TEMPERATURE DIFFERENCE

Sample	Actual Heat Head, Deg. F.	H Computed at Actual Heat Head	H Corrected to 70° F. Heat Head	Relative Humidity	Condensation
1. Single-glazed solid steel	73.9	34.2	33.6	28	All
2. Double-glazed solid steel—¾-in. air space	76.8	21.8	21.6	29	Fifteen outer panes out of 20 showed moisture on air-space side
3. Double-glazed solid steel—3/16-in. air space	76.0	24.2	24.0	30	One outer pane showed moisture on air-space side; one inner pane showed moisture on box side. Three lights showed both the above
4. *Double-glazed wood—⅝-in. air space	79.8	15.5	15.1	31	None
5. Single-glazed wood	67.6	28.9	29.3	29	Twelve lights
6. Double-glazed hollow metal—¾-in. air space	75.6	16.6	16.4	36	On air-space side of one outside pane
7. Single-glazed hollow metal	77.7	30.5	29.7	25	All

*A test upon this same wood sash with the inside panes of single-thick plain glass instead of double-thick showed an increase in H of 3% at 70° F. temperature difference.

These experiments indicate that condensation in the air space of double-glazed sash can be eliminated almost entirely by connecting the air space directly to the outside air and at the same time effectively sealing it from the entrance of the warm air inside. The opening should be very small, equivalent to a ⅛-in. hole, and should be protected from weather and dirt.

*Abstract of paper presented by Arthur N. Sheldon, Providence, R. I., at the annual meeting, December, 1916, of the American Society of Mechanical Engineers, in New York City.

Five Water-Works Make Filter Alum—I

SYNOPSIS—Columbus, Ohio, Trenton, N. J., Springfield, Mass., the Metropolitan Water District of the City of Omaha, and the Montreal Water and Power Co. are making their filter alum by treating bauxite with sulphuric acid. The cold process, producing crystallized alum in cakes, is employed under a patent granted to C. P. Hoover. After an introductory statement, each of the four plants in the United States is described by the engineer or chemist in charge. The Omaha description will appear in a subsequent issue.

Evolution and Status of the Process

The cost of chemicals used in water purification has become so high since the outbreak of the European War that anything new yielding equally good or better results at less expense is doubly welcome. Some 18 months before the war broke out, Charles P. Hoover, chemist in charge of the water softening and purification works of Columbus, Ohio, began a series of experiments on the manufacture of filter alum at the works, using low-grade hydrated aluminous material in its raw state. After two years of experimental and preparatory work he completed a plant and turned out the first product from it on Dec. 25, 1914. This plant was put in regular operation in January, 1915. The hot process was used and a syrup of alum produced, which after dilution was added to the water in the coagulating basin. Since then it has been found expedient to produce crystallized alum instead of using the syrup of alum. For reasons that will be made clear in the following paragraphs, the cold process instead of the boiling process of manufacture has been adopted.

Besides installations producing syrup of alum and also alum cake at Columbus, there are now plants for making alum cake by the later Hoover process at Trenton, N. J., Springfield, Mass., the works of the Metropolitan Water District of the City of Omaha, Neb., and the works of the Montreal Water and Power Co., supplying a portion of Montreal, Que., and various outlying districts. In addition to these five plants on public water-supplies there is one at the factory of the Independent Packers' Fertilizer Co., Columbus, Ohio.

Reduced to its simplest terms and assuming that the bauxite has already been pulverized, the Hoover process requires nothing but a small tank for mixing the baxuite and sulphuric acid, and a large shallow pan or box for allowing the reaction to take place, the water of crystallization to be driven off and the cake to harden so it can be removed. A small motor is required, together with weighing or measuring facilities and other accessories.

In the Hoover as compared with the ordinary commercial process, low-grade ore with relatively high iron content is perfectly satisfactory; and no refinement what-

FIG. 1. OLD AND NEW PLANTS FOR MAKING FILTER ALUM, COLUMBUS WATER-WORKS

ever is attempted, since the foreign elements in the ore are believed to assist in the process of coagulation and precipitation. Moreover, the Hoover process requires less sulphuric acid than the ordinary commercial process and, what is of great importance in the operation of a water-

Mr. Hoover's description of his process, as given in his patent already mentioned, makes very interesting reading to those deeply concerned with the subject; but as it is lengthy and can be obtained from the Patent Office for a nickel, direct citations from it will not be made here.

FIG. 2. MIXING TANK AND ONE OF TWO CRYSTALLIZING BOXES, TRENTON ALUM-MAKING PLANT
The mix is boiling by its own heat and giving off vapor of crystallization

coagulation plant, produces a more highly basic sulphate of alumina.

Under date of Sept. 5, 1916, there was issued to Mr. Hoover, United States Patent No. 1,197,123, containing claims for not only the manufacture of sulphate of alumina by the process already outlined, but also for the treatment of water by the process in coagulation and sedimentation basins. The Hoover Chemical Co. has been organized to promote the process in the United States, with George A. Johnson, consulting engineer, 150 Nassau St., New York City, as manager of the company. The Hoover Chemical Co. for Canada has also been organized. Its manager is J. O. Meadows, 20 Charlevoix St., Montreal.

Mr. Meadows, it may be added, is engineer in charge of the operation of the water-purification plant of the Montreal Water and Power Co., already mentioned. The Columbus and Omaha plants were designed by Mr. Hoover, the Trenton and Springfield plant by Mr. Johnson, and the Montreal plant by Mr. Meadows.

It is well to state in passing that bauxite is found in various parts of the country and can be bought from a number of different companies. Since, as already stated, low-grade bauxite is employed, the price of the ore at the mine is very low—lower than the freight rates when considerable distances for transportation are involved. Halloysite or other native hydrated aluminous materials might also be used, but thus far the bauxite has proved to be more tractable than halloysite.

Descriptions of the four plants on municipal waterworks in the United States will now be given. For reasons that need not be gone into here, the Montreal plant cannot be described at the present time.

Old and New Plants at Columbus, Ohio

By Charles P. Hoover*

The original, or syrup-of-alum, plant at Columbus was the first one to be built. This differs from all the other plants in that the alum is not crystallized. The bauxite, sulphuric acid and water are boiled together in lead-lined tanks. As soon as the solution becomes basic, which usually requires boiling with steam for from 6 to 8 hr., the resultant alum liquor is diluted and then fed into the water under treatment. In the new, or cold-process, plant no steam is required, the heat resulting from the reaction of the acid and the bauxite being sufficient to produce a basic alum. Both the old and the new plants are shown by Fig. 1.

In the new plant the bauxite is weighed in a hopper and the acid in a box, each a part of the old, or liquid-alum, plant. The weighed quantities of acid and bauxite are discharged into a mixing pan, elevated 7 ft. above the floor. This pan is 4 ft. in diameter, $2\frac{1}{2}$ ft. deep and is provided with a double-motion agitator. Bauxite to

*Chemist in Charge of Water Softening and Purification Works, Columbus, Ohio.

the amount of 1,000 lb. and 500 lb. of sulphuric acid are placed in the mixing pan and mixed for a period of 5 min. Then the mixture is discharged into the crystallizing box below, where it spreads out on the floor of the box in a thin layer. In another 5 min. another batch is discharged on top of the first, and this is continued until seven or eight batches have been deposited. In 10 or 15 min. after the mixture is discharged into the crystallizing box, it begins to boil violently, rising to a height of 12 or 14 in. On cooling, the mixture crystallizes into an alum cake having a thickness of from 3 to 3½ in.

The alum is usually made one day and removed the following day. The capacity of a plant depends entirely on the space provided for crystallization. At Columbus 484 sq.ft. are provided, and 5 tons of alum are produced in a day. The time required for mixing the bauxite and the acid is only 35 min. for the seven batches, and it usually requires two men about 3 hr. to remove the 5 tons of alum from the crystallizing pan and pile it in the storage house. The pan is 22x22 ft. in plan and 20 in. deep. It was formed by building a concrete wall on an existing concrete floor.

Low-Cost Plant at Trenton, N. J.

By F. W. Daggett*

Trenton, N. J., since May 1, 1916, has been making the alum used as a coagulant in its mechanical water-filtration plant. The filter plant has a nominal daily capacity of 30,000,000 gal. and is now being operated at an average rate of about 16,000,000 gal. per day.

The bauxite from which the alum or sulphate of alumina is made is mined in Arkansas, ground and put up in 175-lb. bags in East St. Louis, Ill., and shipped from there to Trenton, where it is delivered by the Aluminum Co. of America for $20 a gross ton, f.o.b. at the filtration plant. The ground bauxite has the appearance of cement, with a reddish-brown tint, but is not ground so fine as cement. It contains about 55% of alumina. The sulphuric acid, which is the only other material used in the manufacture of the filter alum, comes in 55-gal. drums. A 60° Bé. commercial acid is used, which can be bought at present for about $20 to $25 a net ton.

The bauxite and sulphuric acid are conveyed by elevator to the fourth floor of the filter building. The bauxite is emptied from bags through wooden chutes into the mixing tank. The acid is siphoned out of the drums. The siphon consists of (1) a piece of steel pipe extending within an inch of the bottom of the drum with its upper end screwed into a fitting in the bung hole of the drum, (2) a short horizontal line of steel pipe connected with the vertical line by a hard-rubber union and (3) a length of rubber hose especially made with a minimum amount of fiber. The pipe is greased for protection against the acid. To start siphonic action, a hand air pump is used, its rubber tube being connected with the fitting in the top of the drum.

The mixing tank is of steel, 6 ft. in diameter and 3½ ft. high (see extreme right of Fig. 2). The tank is not lined. The acid and bauxite are stirred by a revolving paddle having cast-iron teeth. The stirring or mixing process requires 3 to 5 min. It is necessary to discharge the mixture immediately after it is ready and before reaction begins to take place. The mixing-plant tank is emptied by removing one or the other of two rubber stoppers, one placed on each side of the tank, directly over one of the crystallizing boxes.

There are two crystallizing boxes, each about 8x18 ft. in plan with an available depth of 2 ft. (one of these is shown in Fig. 2). These boxes are made of 3-in. yellow pine and have their bottoms covered with paving brick.

When the mix is discharged into the tanks, which are used on alternate days, it looks like liquid paint. In the process of crystallization, the required heat is supplied by the reaction between the acid and the bauxite, so that no extra heat is required. In about 10 min. the mixture comes to a boil (Fig. 2) and gives off steam. In about a half-hour the major reaction is complete. Some 24 hr. is allowed for the hardening and cooling process, although

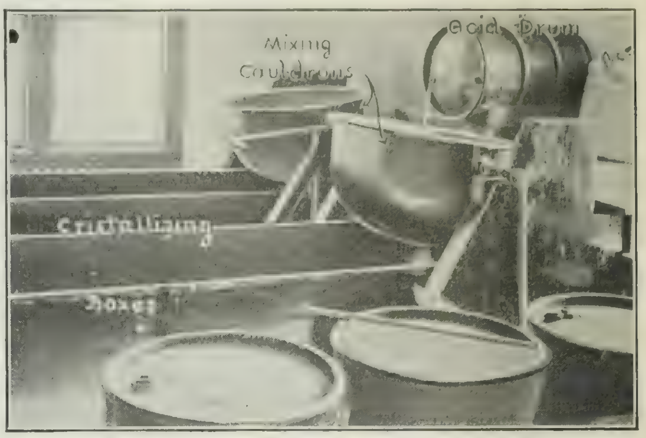


FIG. 3. MIXING CALDRONS AND ALUM CRYSTALLIZING BOXES, SPRINGFIELD, MASS.

perhaps the product could be removed sooner. It suits local conditions at Trenton to remove the alum from the crystallizing box at night, making use of the night shift, which has plenty of time for the purpose.

The layer of alum, or sulphate of alumina, formed in the plant as it is now being operated at Trenton, is some 3 in. thick. It is broken up by a Crown No. 56 coal pick or pneumatic hammer made by the Ingersoll-Rand Co. This tool the city had on hand, having bought it originally for cutting sheet asphalt. A pneumatic railway-tie tamper with a cutting edge has been considered; but the coal pick, as has been said, was on hand, and it works well. Prior to the trial of this tool, hand labor was employed, making use of chisels and picks. These did the work, but not so readily as the pneumatic hammer.

A 6x6-in. Ingersoll-Rand vertical compressor with a capacity of about 60 ft. per min. under 80 lb. pressure, driven by a 10-hp. d.c. Westinghouse motor, operates the air hammer and paddle in the mixing tank—each is required, but not at the same time.

The plant described produces about 2,500 lb. of filter alum per day. It is said that double that amount could be produced by the same installation, if it were needed. The total cost of the plant was about $2,200. Some of the material was on hand, including the tanks, but the latter had to be altered. As the plant stands, the tanks, crystallizing boxes, etc., cost about $600; the air compressor, $350; and the motor, $150.

The cost of the filter alum produced by the plant is about $32 per ton, but at current prices for acid it would

*Superintendent of Water-Filtration Plant, Trenton, N. J.

not be over $25. Commercial filter alum is now selling for something like $60 per ton. The city is paying Mr. Hoover a small royalty. According to the present outlook the city will be able to make a net saving, for the first year of its alum manufacturing, of about $6,000.

The Trenton filtration plant is operated under the direction of the writer, who was engineer on the construction of the plant in behalf of Johnson & Fuller, consulting engineers of New York City. Alvin Bugbee is superintendent of the Trenton water-works.

Simple Plant at Springfield, Mass.

By Elbert E. Lochridge*

On July 5, 1916, a plant for the manufacture of sulphate of alumina at the West Parish filters, Springfield, Mass., was put into operation. As the method of applying the sulphate at this plant is that of overdosing and intermittent application, the total amounts required are less than would normally be provided for a plant delivering approximately 12,000,000 gal. of water per day.

The normal capacity is 1,000 lb. of alum per day; and it is actually operated substantially every day at this rate, although amounts up to 1,200 lb. have been delivered on certain days.

The plant (Fig. 3) consists of two 83-gal. iron caldrons, suspended above the end of two wooden crystallizing boxes, each 8 ft. in length, 3 ft. in width and 2 ft. deep. The sulphuric acid and bauxite are mixed in these caldrons and dumped directly to the crystallizing boxes, where the chemical reaction takes place. A steel plate is fitted in the bottom of these boxes to facilitate breaking the cake, and the wood is treated with acid-proof paint. Just at the completion of the reaction and before the cake has become too hard, it is cut up into small squares by pushing a crowbar along the plate, and it hardens in this form.

As the method of application to the water at this plant is "dry feed," a 15x8-in. Type D Jeffrey crusher with a 10-hp. motor is used to crush the alum to proper size for use. The plant is situated on the second floor of the main building, and from this second floor the finished product is fed directly to the hopper above the screw conveyor delivering the alum to the water.

The bauxite and acid now on hand cost respectively $17.50 and $65 per ton, f.o.b. Springfield, Mass. In the case of the bauxite this included shipment from Arkansas to East St. Louis, pulverizing at that point and reshipment to the plant. The cost per ton at East St. Louis is $12. The acid cost includes 135 drums and shipment from Chicago. Very much better quotations have been received since these amounts were paid. With the crusher now installed it is planned to pulverize the bauxite at the plant, thus saving the shipment via East St. Louis. This will reduce the bauxite cost at least 50%.

It is rather difficult to figure labor cost with the short period of operation, as the work is carried on by our regular men and no extra labor is employed. The cost of hauling all material from the railroad station to the filtration plant, 5 mi., is $1.75 per ton. The total cost of the plant, in addition to the royalty to the Hoover Chemical Co., was $756. This includes crystallizing boxes, crusher, motor, caldrons and labor.

*Chief Engineer of Water Board, Springfield, Mass.

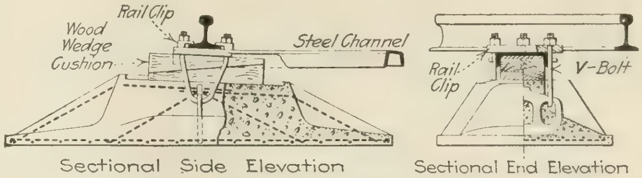
The plant has been in operation constantly since it was started and has never failed to produce sulphate of alumina of a satisfactory quality. Comparative tests on its coagulation properties per pound have been carried on to determine proper dosing, and in this manner the strength has been kept substantially the same as that of regular market alum as formerly used.

Concrete Ties in Holland

An experimental track in which the ties are composed of pairs of concrete blocks connected by transverse steel tie-bars is in service on the Amsterdam-Utrecht line of the Netherlands State Railways, in Holland. In principle the tie resembles the Kimball ties tried in this country on the Chicago & Alton Ry., and the Denham-Olpherts cast-iron plate ties that have been used extensively in India.

Each tie is composed of a pair of reinforced-concrete blocks about 4½x3 ft. on the base, with a maximum height of about 12 in. The top surface is about 36x18 in. with flaring ribs to the corners of the base, and its top forms a seat for a pair of wedge-shaped wood blocks. Upon the wood cushions of a pair of concrete blocks rests the ends of a transverse inverted steel channel. Upon this rest the 92-lb. T-rails and rail clamps.

The rail fastenings are of curious design. At each block the rail is held by a pair of deep V-bolts, or stirrups, the loops of which pass through the projecting ends of cast-iron anchors embedded in the concrete. The threaded ends of the bolts pass through the rail clamps. In surfacing track the adjustments are made by loosening these bolts and adjusting the wood wedges, the concrete blocks being left undisturbed, as tamping is liable to result in causing cracks.



TRACK WITH CONCRETE BLOCKS AND TRANSVERSE STEEL CHANNELS; NETHERLANDS STATE RAILWAYS

The weight is about 440 lb. for each block. The weight per lineal foot of track is about 1,500 lb. (including ballast filled over the base of the blocks), and the cost about $6.20, as compared with 600 lb. and $5.75 for the ordinary track construction. But this weight and cost for the experimental track are obtained at the expense of the support of the rail, the spacing being 4 ft. c. to c. (or 2 ft. at the rail joints). Such wide spacing of rail supports is undesirable in track construction, and is only introduced to minimize the cost. The experimental track is only 120 ft. long. It carries considerable traffic, but the trains run at low speed, as it is near the city of Utrecht. It has been in service for about two years and is said to be generally in good condition, although cracks have developed in some of the blocks.

Dredge Raises Fuel Barge—The combination suction and dipper dredge "Monticello," belonging to the Government, raised a barge loaded with sawdust near St. Helens, Ore., in the latter part of November. The load of sawdust was transferred by bucket conveyor from the sunken barge to another moored alongside.

Roosevelt Drainage Tunnel of the Cripple Creek District

SYNOPSIS—The Roosevelt drainage tunnel is the most important mine-drainage project since the famous Sutro tunnel of the Comstock mines, Nevada. It is an undertaking that will cost nearly $1,000,000. A historical sketch of the drainage of the district is given.

The Cripple Creek mining district is an area of eruptive or volcanic rock, of an irregular oval shape, 3 to 5 mi. across and of unknown but probably great depth. Small as this district is in area, it has already produced $360,000,000 in gold (since its discovery in 1891) and it is still producing at the rate of $15,000,000 yearly.

The district is entirely surrounded by impervious granite walls. It is apparently an immense crater. This volcanic mass has been fissured by many successive eruptions and contains innumerable cavities and crevices of all sizes and shapes. During all the ages that have elapsed since the eruption, surface water has permeated down and through these cavities until the crater was saturated up to the notches in the edges of the granite walls. T. R. Countryman, who has studied the district for many years, estimates the storage of this underground reservoir to be at least 40,000,000 gal. per vertical foot.

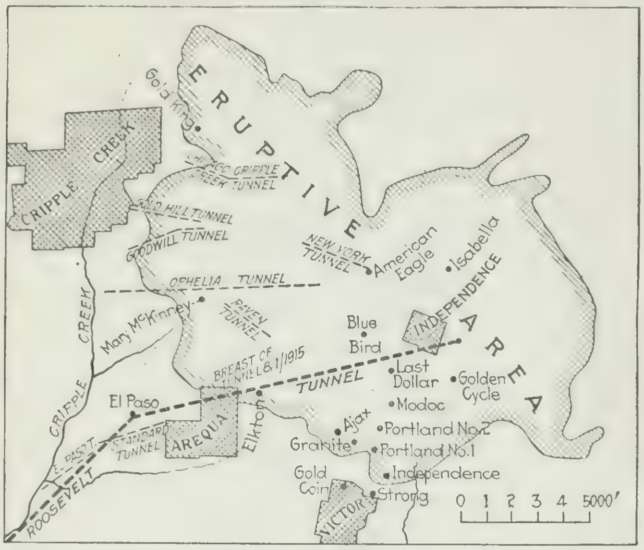


FIG. 1. MAP OF CRIPPLE CREEK MINING DISTRICT AND DRAINAGE TUNNEL

Early Problems of Drainage

In the earliest days of Cripple Creek mining the water question was not a serious one; but as the important mine shafts increased in depth, the seepage began to be very troublesome, and below 500 ft. the mining operations were greatly hampered. The original water level was about 9,500 ft. above sea level on the western side of the district and 9,700 ft. on the eastern side (about 200 ft. below the surface). The first mines to do considerable pumping were those in the southwestern corner of the district, notably the El Paso and the Elkton.

At first, each mine constructed its own pumping plant, but as the depth of the workings increased, the cost of pumping became enormous. Several joint pumping plans were tried, but none was very successful. The pumping plant at the Portland mine, installed in 1898, cost $3,000 a month to operate and handled only 525 gal. per min.

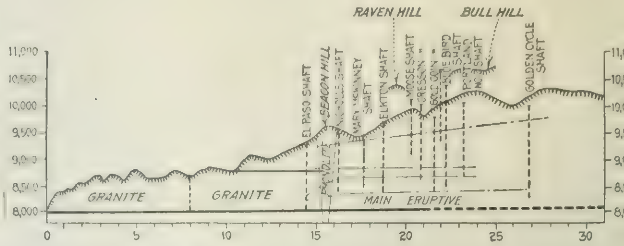


FIG. 2. PROFILE OF ROOSEVELT DRAINAGE TUNNEL, CRIPPLE CREEK, COLO.

The cost of the plant was not less than $50,000. The Elkton mine in an effort to develop the 800-ft. level pumped continuously from 1901 to 1902, but had eventually to give up.

About this time the first tunnel of the district, constructed solely for drainage purposes, was undertaken. This was the El Paso tunnel, constructed by the El Paso mine to drain its lower workings. Previous to that there had been three tunnels that had served for drainage as well as for workings, the most important of these being the Standard tunnel. The Standard tunnel was driven in 1895, and it is estimated that it discharged 12,000 million gal. by 1901, when it became dry. The El Paso

FIG. 3. PORTAL OF ROOSEVELT DRAINAGE TUNNEL DISCHARGING 17,000 GAL PER MIN.

tunnel was begun in 1902. It is 5,000 ft. long and of a cross-section $4\frac{1}{2}$x7 ft. It cost \$90,000, and it is estimated to have saved \$1,150,000 in pumping. It lowered the water in the Elkton mine shaft more than 5,000 ft. distant, nearly 200 ft. The elevation of the El Paso tunnel portal is 8,786 ft. and it was driven at a grade of 0.28 ft. per 100 ft., or 1 in 357.

When the El Paso tunnel had served its purpose, a larger and deeper tunnel was planned. Every hundred feet added to the depth of a drainage tunnel in the district meant 1,000 ft. added to the length and \$30,000 to the cost of the work. No particular engineering difficulties were anticipated or have developed, but the work has proved a test of strength and endurance.

Beginning of the Roosevelt Tunnel

The elevation of the floor of the Roosevelt tunnel at the portal is 8,034 ft. above sea level (making it 750 ft. lower than the El Paso tunnel), and it has a grade of 0.3 ft. per 100 ft., or 15.9 ft. per mi. (1 in 333). Its depth below the surface at the El Paso mine shaft is

FIG. 4. HEADING IN ROOSEVELT DRAINAGE TUNNEL

1,289 ft., and at the Elkton mine shaft is at a depth of about 1,640 ft. It discharges into Cripple Creek Cañon about 5 mi. below the City of Cripple Creek.

The tunnel cross-section as originally designed was 10 ft. high by 7 ft. wide in the clear, with a waterway 3 ft. deep by 6 ft. wide on one side and a shelf on the other for the mine-car tracks.

The work was begun on June 1 and continued until Dec. 1, 1907, when the original contractor abandoned the contract. Work was continued for 300 ft. and again abandoned until January, 1908, when a contract was let to A. E. Carlton, a well-known Cripple Creek banker and mine owner. The cross-section of the tunnel was then changed to 10 ft. wide by 6 ft. high, with a ditch or waterway on one side 5x3 ft. in cross-section.

At a distance of 8,000 ft. from the portal an intermediate construction shaft was sunk 700 ft. deep to the tunnel level, on the tunnel center line. From the bottom of this shaft the work was started in both directions and thereafter was pushed at all three headings night and day.

All the tunneling as far as the El Paso mine shaft, 14,500 ft., was in hard granite, in which it required 24

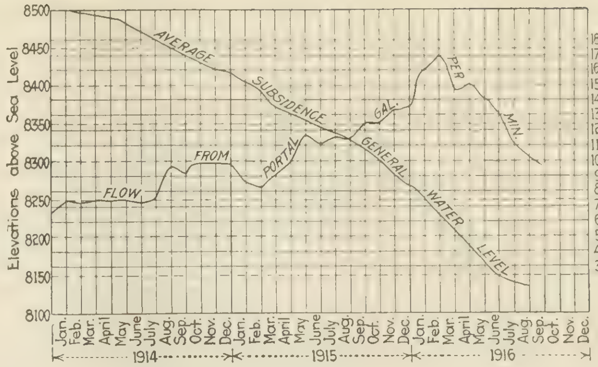


FIG. 5. EFFECT OF ROOSEVELT DRAINAGE TUNNEL ON MINE WATER LEVELS

to 30 holes and sometimes 300 lb. of powder to break a round 5 ft. deep. The best monthly record was 400 lin.ft. in October, 1908. The cost of this part of the tunnel was \$27.27 per lin.ft. The center line of the three headings differed less than 2 in., while the grade of the floor was practically correct. The tunnel reached a point opposite the El Paso mine shaft on Aug. 1, 1910. Here a deflection to the right was made, as the plan, Fig. 1, shows.

By March, 1911, the funds of the tunnel company were practically exhausted, and the tunnel was stopped about 1,000 ft. beyond the El Paso mine shaft. In the fall of the same year the company raised additional funds, and the work was resumed in the main heading to a total distance of 16,857 ft. from the portal. At this point a large open fissure, or vein, accompanied by a heavy flow of water, was encountered, together with caving ground, which made the work extremely difficult, and it was abandoned in March, 1912.

In June, 1914, work was again resumed with the intention of driving the tunnel on to the Vindicator mine, a distance of 10,000 ft. When the work on the original tunnel stopped in March, 1912, all pipe, track, ven-

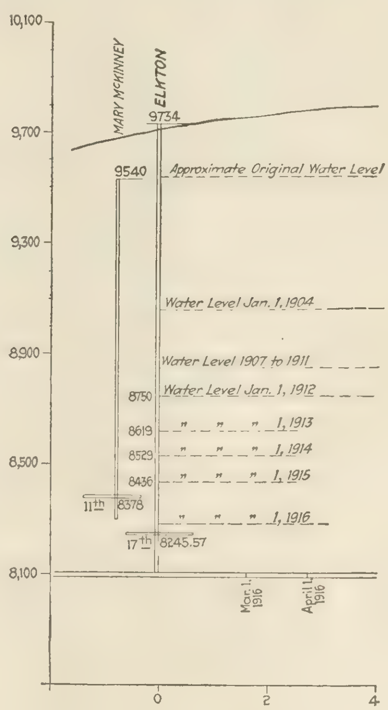


FIG. 6. EFFECT OF ROOSEVELT TUNNEL AT ELKTON MINE

tilating apparatus, etc., had been taken out. All these had to be replaced, and 1,100 ft. of ditch had to be cut in the tunnel already constructed.

Drilling was commenced in the heading on Aug. 3, 1914, and it was deemed advisable to make a detour to the north of the old tunnel line to avoid the bad cave in the breast of the original tunnel. This detour was commenced 55 ft. back from the breast and ran in a northeasterly direction for a short distance and then back to the line of the original tunnel. Some bad ground was encountered soon after the commencement of the work, and considerable heavy timbering had to be done. By September the bad ground had been passed, and good progress was made until Nov. 1, 1914, when the El Paso mine plant was destroyed by fire, and work on the tunnel had to cease.

The equipment for driving the tunnel consisted of a track of 20-lb. rails and a motor and blower in the tunnel a short distance from the El Paso shaft on the portal side, where there is good natural ventilation. The ventilation in the breast is supplied by a 16-in. pipe. The compressed air for the drills was obtained from the El Paso compressors and was taken to the breast in a 2½-in. pipe. Stables for three mules and a machine shop for minor repairs were situated near the blower. The tunnel was lighted by electricity.

Work was begun again early in 1915 and has been continued to date. In the spring of this year, after a connection with the Elkton mine shaft, the ventilating machinery, mule stable, etc., were moved to a new location near the foot of this shaft. The tunnel is now over 4 mi. long and over 1,800 ft. below the surface. Its width is 9 ft., and it is 8 ft. high in the clear, with a ditch or waterway on one side 4x2 ft. deep. The tunnel has passed out of the granite and is now being driven in a hard volcanic breccia with occasional dikes of basalt and phonolite, which are both very hard.

Usually it requires 30 holes to break a round only 5 to 7 ft. deep. Very little timbering, however, is necessary. The work is being done with three shifts of eight men, at a cost of from $20 to $25 per lin.ft. The rock is hauled from the breast by a mule and is now taken out of the Elkton mine shaft. Previous to the connection with this shaft, all the mucking had to be done via the El Paso shaft, 1 mi. distant. The mucking cars had to travel in water 2 to 3 ft. deep. The drills used are Ingersoll-Leyner Model 18, with 2½-in. bits for starting. Two drills on a horizontal bar are worked in each shift. The best record yet made is 456 lin.ft. in September of this year.

Aside from the point where the tunnel was abandoned on account of caving ground, the most inconvenience has been caused by the water, which flows in from all directions, sometimes in streams of 5,000 gal. per min. These often spurt out of the heading into the faces of the workmen, who require patience and persistence to keep at work. The connection with the Elkton mine shaft was a particular instance, as the junction was driven upward from the tunnel cross-cut, and great quantities of water were continually coming down upon the heads and shoulders of the drillers. Fortunately the water is at a temperature of between 60° and 70° F. and is not so disagreeable to work in as it would be were it cold or hot.

The tunnel has discharged as much as 17,000 gal. per min., as the diagram in Fig. 5 shows. The flow, however, is now rapidly falling off, which substantiates the theory that the reservoir is being rapidly drawn down. The diagram also shows the effect of the tunnel on the water levels at the Elkton mine shaft and in the mine shafts of the district as a whole.

T. R. Countryman, consulting engineer, Cripple Creek, Colo., is chief engineer of the tunnel project and has been associated with it and with previous tunnels since their inception. He is indeed the original projector of the scheme of draining the district by tunnels. The work in 1914 was supervised by E. P. Arthur, Jr., as engineer. Since then the work has been supervised by Charles F. Fuller as superintendent. The facts given are based on a trip through the tunnel by one of the editors and on material kindly furnished by Mr. Countryman.

Dispatcher's Selective-Control Railway Signal System

By John B. Harlow*

By combining a block-signal system with equipment developed for telephone train dispatching, the Western Electric Co. has evolved a unique railway communication system that enables a train dispatcher to set signals anywhere on his division, to know when the signal moves and from what direction a train enters a block—all without the aid of the way-station operator.

This system was shown at the recent annual convention of the American Electric Railway Association in Atlantic City, but it is of as great interest to steam roads as electric interurban lines.

The basis of this system really is the new so-called alternating-current selector developed for telephone train dispatching. In the regular train-dispatching circuit there is a selector located at each way-station, while in the dispatcher's office there is a bank of keys, one for each way-station selector. With that equipment in place, when the dispatcher wishes to call any particular station, he operates the key marked for that station. The key sends impulses over the line in a predetermined combination that will close the contact of the selector at that particular station and operate a bell to call the way-station operator.

This new selector, shown in Fig. 1, operates on reversals of polarity at a frequency of about 3½ cycles per second. Since it is operated through a condenser, it will not respond to uni-directional impulses and is therefore particularly well adapted for use on lines that might be crossed with telegraph, trolley or other wires carrying direct current. The impedance of the selector to alternating currents of commercial frequencies is so high that it would take an extremely high voltage across the selector terminals to operate it at all. Thus, the chance of false closure of a contact due to a foreign source of potential is reduced to a minimum.

In the control of signals the selector contact is used to operate a relay in place of the bell. For this service the selector is provided with two contact points, one of which is used to set the signal and the other to clear it, as shown in Fig. 2. When the set contact is closed, the setting relay is energized and will open the feed to the

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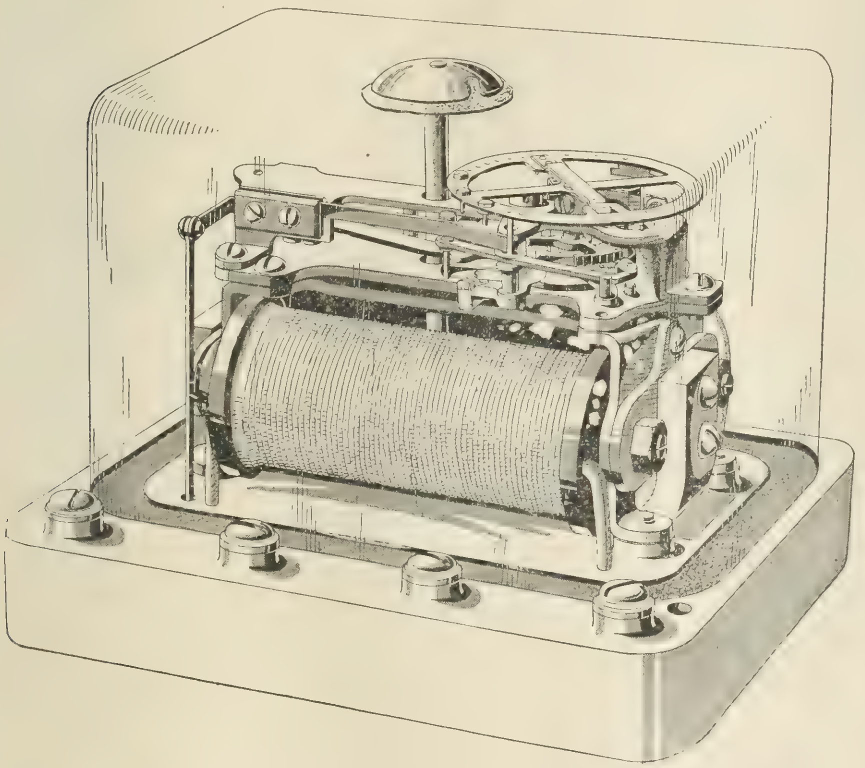
line relay controlling the signal, causing the signal to come to the stop position. The setting relay locks up through the back contact of the clearing relay. Thus, the feed to the line relay of the signal circuit is held open until the dispatcher closes the circuit that energizes the clearing relay.

Since a scheme of this sort to be of any great use to the dispatcher must give some indication that the signal has responded correctly, a simple but effective form of answer-back or indication is used. In series with the setting relay is a second relay that controls the answer-back. This relay on being energized starts up a small motor that revolves a shaft at about 40 r.p.m., on which are mounted toothed wheels. These teeth are cut so that a definite code will be given in the same manner as in a fire-alarm or messenger-call circuit.

Each signal will have two distinct codes, one for its set position and one for its clear position. This is accomplished by having on the motor shaft two wheels which are connected in the answer-back circuit through contacts on the line relay, the particular wheel being determined by the position of the line relay. This code is repeated as long as the dispatcher holds the contact closed on the selector.

These signals can be used strictly as train-order signals entirely separate from the automatic block circuit, or they can be the home signals of the automatic block system itself. Fig. 2 shows the application to the home signals of an automatic block circuit. The system in no way interferes with the safety of the block-signal circuit, as it is impossible for the dispatcher to clear a signal if a train or car occupies the block. Thus, all that can happen is that a signal will be held at the stop position.

In the Western Electric exhibit at Atlantic City a working model of this system was shown. The block-signal circuit used was the traffic-direction block, or



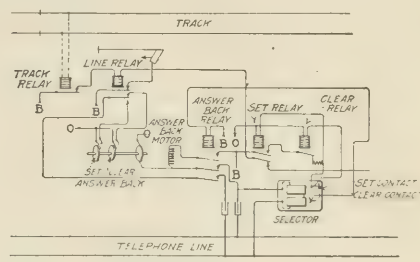


FIG. 2

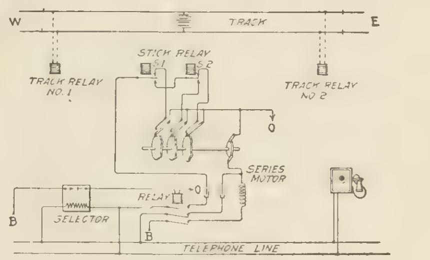


FIG. 3

SELECTOR AND CIRCUITS FOR NEW DISPATCHER'S TRAIN-SIGNAL SYSTEM

"T.D.B." system of the Union Switch and Signal Co. This system has relays in its circuit, which can readily be used to give the dispatcher information regarding the movement of trains in a given block by the operation of a selector, either separate from one of the signal selectors or by utilizing a third point on a signal selector. A relay is closed, which starts up the answer-back or code-sending motor; and one of three different codes will be sent to the dispatcher as long as he holds the contact of the selector closed. If no train is in the block, one code will be given him; if a train has entered the block from the east, a second code will be sent; and if a train has entered the block from the west, a third code will be sent. The way this is done is shown in Fig. 3.

The signal circuit makes use of a center-fed track circuit, and located in the circuit are two stick relays S1 and S2. The circuit is so arranged that a train entering from the east, track relay No. 2 being deënergized, will energize stick relay No. 2, which will stay locked up until the train has passed through the block or has left it either by backing out or going into a siding. A train entering the block from the west, track relay No. 1 being deënergized, will energize stick relay No. 1, which will come up and lock up until the train has left the block. By means of contacts on these relays, as shown in Fig. 3, it can be seen that one of three different code wheels can be connected to the answer-back circuit, (1) when both stick relays are deënergized, (2) when stick relay No. 1 is energized, or (3) when stick relay No. 2 is energized.

By having this apparatus in each block it is possible for the dispatcher to inform himself of the state of traffic at any point.

It must be remembered that this system is used merely as a means of conveying information to the train crews or to the dispatcher. It in no way affects the safety of the signal system and is merely superimposed on the signal system to enable the dispatcher to keep in close touch with his trains without the aid of a third party—the way-station operator. In this way the system looks toward the final elimination of the operator at the way-station.

The Miami Valley Flood-Protection Work

I—Fixing Maximum Flood Limits

A Pioneer Study of Storm Records in the United States; Analysis of Storm Frequencies, and Prediction of Future Storm Possibilities in the Central Region; The Final Result, Ten Inches Runoff in Three Days

After the terribly destructive flood of Mar. 23-28, 1913, the people in the valley of the Great Miami River, Ohio, made an urgent appeal for protection against future floods. This put a wholly new problem before the engineers who were called in to devise such protection. They had to determine what future great floods might visit the valley; or, still more difficult, what is the *greatest* flood that may come. No such forecasting had ever been done for a stream and a drainage area like the Miami, or for intense rainstorms covering thousands of square miles.

While this problem may seem like one of pure prophecy, it was actually solved by means of a monumental research into rainfalls and floods. Records were fully analyzed, and their facts extended into the future by an interesting combination of judgment and calculation. From an examination of this work, it can be asserted with all confidence that the first premise of the great Miami flood-protection enterprise rests on a thoroughly sound basis.

The research is of entirely new nature. Similar work will undoubtedly be needed elsewhere in the future. Fortunately, many of the data collected in the present research are applicable to other regions; but some of them are valid for the Central States region only, and possibly are even more limited than this. The distinction between the two classes of results must be carefully observed.

The Starting-Point of the Work

To state the final results in advance, Figs. 1 and 2 are given. The former shows the Dayton plain in flood in 1913, and as it would be flooded by the ultimate maximum flood. It also shows how both floods are to be controlled by the retarding basins, which form the central feature of the flood-protection works soon to be built.

Fig. 4 gives the adopted flood-flow curve, the runoff of the ultimate greatest storm covering the entire valley, as used in designing the Miami plan. Comparison of the two upper lines of the intensity diagram with the dotted line, showing the 1913 intensity, expresses clearly what excess is provided for. The same appears from the diagram of accumulated flow, the right-hand diagram in Fig. 2. For better understanding of the two diagrams, the rate of flow is expressed not only in inches depth, but also in second-feet per square mile. In the accumulated-flow diagram the retarding-basin capacities (to spillway level) are represented, showing how little is left for the stream channels below, even in the greatest flood.

Though the 1913 flood, which overtopped the levees at Hamilton and Dayton by ten or a dozen feet, was greater than any Miami flood in living memory, yet it was taken as a storm that undoubtedly must be protected against. Further, the engineers brought with them knowledge of some of the greatest storms recorded in the Central States. The largest of these, the storm of October, 1910, centering near the mouth of the Ohio River, in Illinois, Kentucky, Tennessee and Missouri, was typical of summer or fall storms in having a low ratio of runoff; yet in total amount of rainfall it was about 15% greater than that of 1913 for an area equal to the Miami watershed. It was kept in mind as a provisional maximum, while detail investigations were being made.

There was no lack of popular belief that such a flood as the one of 1913 could not happen again, that it is not in the regular order of natural phenomena, but represents a cataclysmic happening. At the same time it developed that even men in close touch with weather and flood matters were not fully informed as to great storms. Under the circumstances the engineers felt it vitally necessary to look up storm records in the most thorough manner possible, with a view to supporting or modifying their views by the results of study of past flood history and estimate of future possibilities. Such a research was at once entered upon.

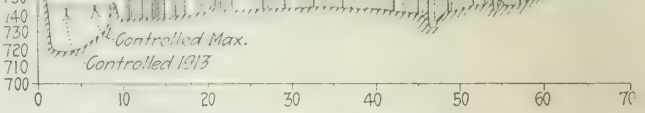


FIG. 1. CROSS-SECTION OF THE DAYTON PLAIN
Flood of 1913, with actual possible and controlled flood stages

Confirmation of the starting-point ideas was obtained in a very short time. On bringing together the historical records of the Miami Valley and reducing the vague data of 70 and 100 years ago to figures as well as trained judgment would permit, two facts came out: First, since the coming of the white men there has been no Miami flood equal to that of 1913, not merely in gage-height and extent of inundation, but also in volume. Second, indications are that one or two prior floods came within reaching distance of 1913. The 1913 flood, while considerably greater than earlier recorded ones, is not so pre-eminently ahead of them as to constitute a cataclysmic phenomenon. Rather, it forms a natural and harmonious element of a progressive list, though for the Miami it indisputably stands at the top of the list. This latter fact was modified and made very prominent by the subsequent researches, which examined conditions outside the Miami Valley.

Great Storms and Floods in the Past

Two points had to be determined by the research: What storms and floods have happened in the past, and what are to be expected in the future. No physical evidences that gave help in the matter were found in the valley. The limited period of the records for the Miami needed extending by the aid of records from other regions.

Studying the records available at Dayton and in the Columbus office of the Weather Bureau proved insufficient.

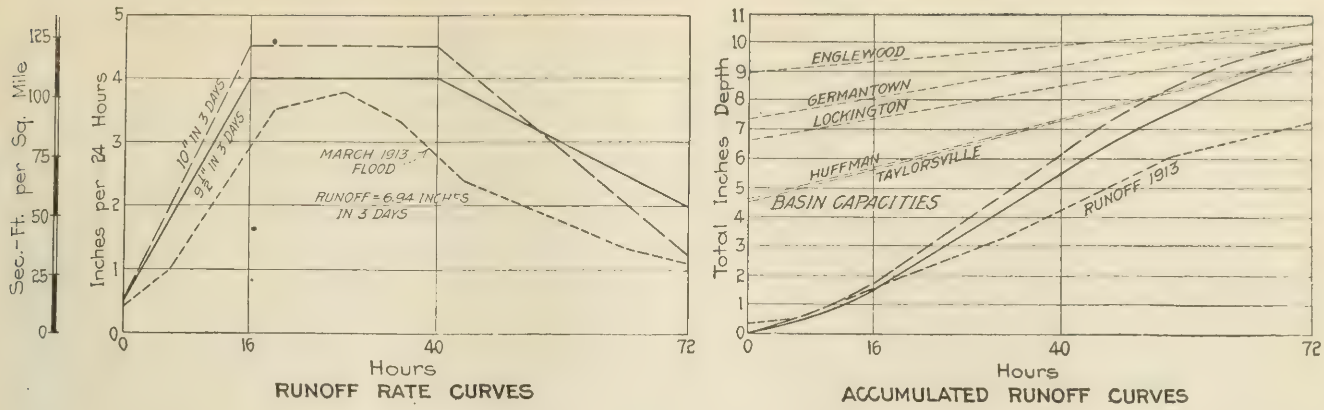


FIG. 2. RUNOFF AND ACCUMULATED RUNOFF CURVES FOR THE MIAMI VALLEY; THE MAXIMUM POSSIBLE, AND THE 1913 FLOOD

The capacities of the five retarding basins are represented by the straight lines in the right-hand diagram; the ordinate at zero hours represents the initial capacity, while the other ordinates represent initial capacity plus conduit discharge.

Therefore several men were sent to Washington and spent eight months there, abstracting the entire storm rainfall records of the country.

The Miami area, 120 mi. long, northeast to southwest, by 50 mi. wide, containing 4,000 sq.mi. (exclusive of the tributary Whitewater near the mouth), lies in 40° to 41° latitude and at 800 to 900 ft. elevation above sea level. Its climatological character is the same as that of the whole Ohio River basin, and experience throughout the basin is therefore pertinent testimony.

Storm Abstracts—The rainfall records of all storms in the weather records of the United States east of 103° longitude were abstracted. All rainfalls were noted down that exceeded the following limits: 1-in. precipitation in 24 hr., or 4 in. for the total storm, where the normal annual rainfall is below 20 in.; and 10% of the annual total in one day, or 15% of the annual total in the whole storm, for stations whose normal annual rainfall exceeds 20 in.

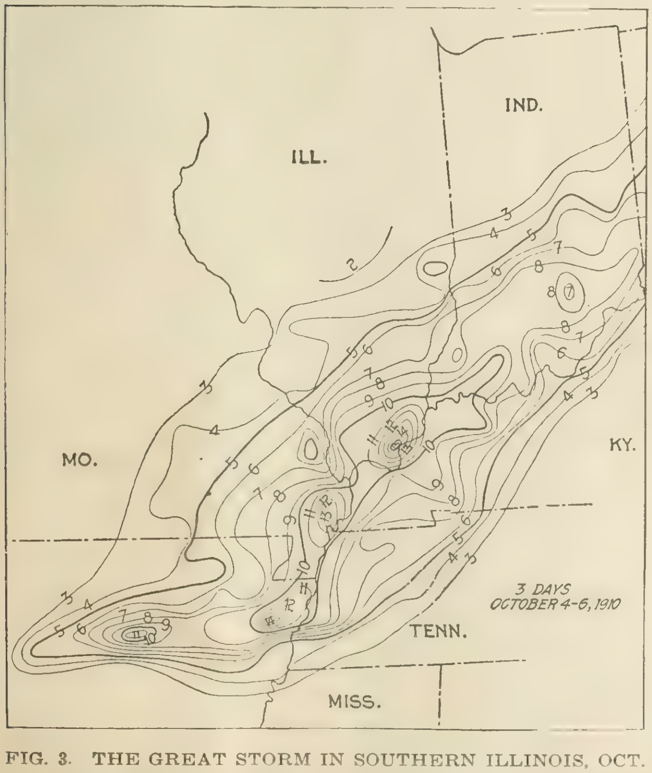


FIG. 3. THE GREAT STORM IN SOUTHERN ILLINOIS, OCT. 4 TO 6, 1910; THREE-DAY RAINFALL DEPTH CURVES

Each station (some 3,000 observing stations were included) had a separate sheet, where besides the daily rainfall were given for each separate storm the one-day total, the two-day and three-day accumulations and sometimes four-, five- and six-day accumulations.

Districting the Country—For easier orientation the whole country (east of 103°) was now districted into 2° quadrangles (divided on the odd degrees); they numbered 133. Designating the rows by numbers and the files by letters, each quadrangle (as 9 E for the Miami) could readily be recognized with respect to its neighbors. Stations on each quadrangle were designated by a, b, c etc., progressing southwest from the northeast corner. Thus, station 9 E z is in the neighborhood of 10 F a Marking the station sheets accordingly, ready grouping of the storm rainfalls of separate stations into single storms was possible.

A "storm index card" was made for each storm—about 3,500 in all—by bringing together the corresponding precipitations shown by adjoining stations, as traced out through the system of designation just described. This paved the way for drawing storm maps, to furnish a basis for time-area-depth studies.

Time-Area-Depth Studies of Storms

Half of all the storms indexed were found to be one-station storms. Two- to six-station storms amounted to 35%, while 15% covered more than six stations. The latter received nearly all of the subsequent study.

It is necessary to remember that the point of importance now was not the greatest rainfall intensity, nor the greatest 24-hr. precipitation at one station, but the

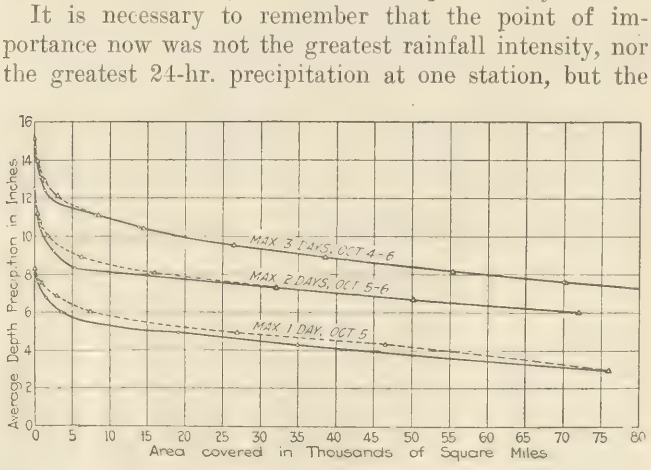


FIG. 4. TIME-AREA-DEPTH CURVES OF RAINFALL FOR SOUTHERN ILLINOIS STORM

greatest accumulated mass of precipitation over a large area during a period of several days. Storms had to be compared on the basis of the three factors of area of storm, duration, and accumulated depth of rainfall. Drawing contour maps of accumulated rainfall was found

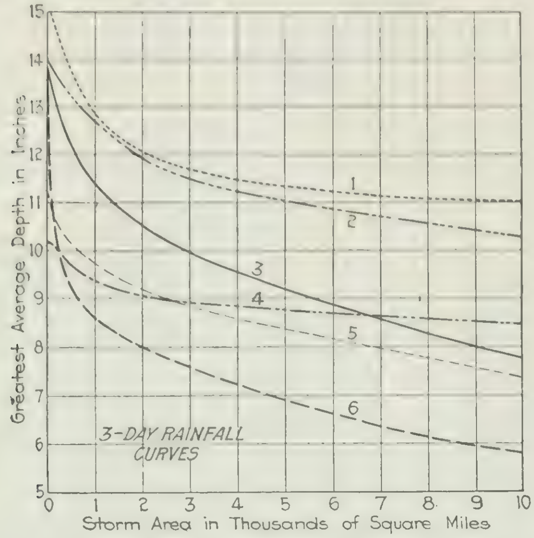


FIG. 5. THREE-DAY AREA-DEPTH CURVES FOR SIX GREATEST STORMS IN THE CENTRAL BASIN

1—Southern Illinois, Oct. 4 to 6, 1910. 2—Arkansas, Aug. 17 to 20, 1915. 3—Iowa, July 14 to 16, 1900. 4—Ohio, Mar. 23 to 27, 1913. 5—Kansas, July 5 to 8, 1909. 6—Michigan, July 19 to 22, 1909.

to be the best means of deriving the curves needed for the comparison.

Only storms covering at least 500 sq.mi. and with maximum intensity of at least one-fifth the total annual rainfall were selected for mapping. Of 46 such storms, the 27 greatest were finally chosen. The nature of the maps is illustrated by Fig. 3, showing the southern Illinois storm of Oct. 4 to 6, 1910; the three-day map is given, those for other lengths of time being similar in general appearance.

The time-area-depth curves for the same storm are shown by Fig. 4, which includes the curves for one to three days. Similarly, Fig. 5 shows in grouped arrangement the three-day area-depth curves for six storms, of which five occurred north of the Ohio River and east of the Dakotas. These (and three others that reached a limit at two days) are the great storms of the Ohio River basin, a region which is a unit as concerns factors of climate and storm incidence. Three of them were much heavier three-day storms than that of 1913[1], and these obviously were possible storms for the Miami Valley.

The storm records showed the general fact that the maximum intensity does not occur at the start of a storm, nor at the end. The heaviest day's rainfall in any storm was found likely to be about half the total of the storm. On the basis of these facts the general shape of the flood-runoff curve (Fig. 2) already began to outline itself.

Long-Time River Records

The storm records thus compiled cover only a moderate period of years, but a sufficient length of time to include several very exceptional occurrences. The question of whether the possible maximum could perhaps be *very much higher*—that is, whether a wholly abnormal great storm might occur some time—was cleared up by a study of old river-flow records.

Ohio River stages at Cincinnati are recorded for 130 years. The Seine at Paris has records for 300 years, the Danube at Vienna for nearly 1,000 years, and the Tiber at Rome for 2,000. In none of these records was any indication of periodicity found. They tell, further, that the greatest flood in a thousand years does not very largely exceed the flood of a magnitude recurring about once in 50 years.

All great floods come within a few feet of each other, and "there has been no great exceptional flood that brought down half again or twice as much water as the other great floods."

The conclusions that could be drawn from the facts developed were expressed very concisely by Chief Engineer Arthur E. Morgan in his testimony before the Conservancy Court a few weeks ago:

> The 1913 flood was one of the great floods of centuries, but in the course of three or four hundred years we may get a flood 15 or 20% greater. We think that is possible, but do not believe we will ever get a flood greater than 20 or 25% in excess of the 1913 flood. But as stated before, we have a factor of ignorance against which we must provide, and the only way we can do this is by arbitrarily increasing the size of the maximum flood provided for. If we had longer records, we could estimate closer; but we believe that in planning works on which the protection of this valley depends, we must go beyond our judgment in the matter. We have done this on every other phase of the design, and we believe that it will not be good engineering practice to stop at our judgment on this phase. We must be able to say that our engineering works are absolutely safe in every respect, and for this reason we have gone 15 to 20% beyond what we believe to be the greatest possible storm, and have provided for one 40% greater than that of March, 1913.

To secure further evidence bearing on the conclusions, the storm records already compiled were analyzed to get the average time-interval of storms of a given size.

Time-Incidence of Storms and the Maximum Long-Time Storm

The underlying idea of the frequency studies was that the storm experience of one station or one quadrangle adds to that of others. The total experience-period, therefore, is the sum of the separate experience-periods. In detail, two methods were pursued—short-time and long-time.

Method A—For each quadrangle the years of record for the several stations were summed; also, the total number of occurrences of a given storm intensity was counted. Dividing the former number by the latter gave the years interval for that particular intensity of storm.

By carrying out this process for a one-day storm intensity equal to 10% of the annual rainfall, and for successive ½-in. additions to this amount, a one-day frequency curve for the quadrangle was constructed. Similarly, a two-day curve was drawn, starting with a fall of 15% of the annual in two days. Three- and four-day curves were drawn where possible.

Fig. 6 reproduces the three-day frequency curve for the Miami quadrangle (9 E). It is evident that the desired maximum storm value is the greatest ordinate of this curve extended far to the right; and the maximum based on all experience in the same climatological region, not merely the Miami experience, would be found by getting the extreme ordinate of a similar curve drawn from the aggregate record of all the quadrangles.

[1]The 1913 storm totaled 7.6 in. on the Miami area, but was heavier a little to the west. The maximum fall on an area as large as the Miami, but lying partly outside, was 9 in. in three days.

Verification of the general shape of the curves is afforded by Fig. 7, a set of frequency curves computed for selected stations along the belt extending from Texas northeast to Maine, frequented by low-barometer areas. These curves, with others computed for the fortieth-parallel belt and for a north-south Mississippi Valley belt, reveal the existence of several distinct types of curve. Among these the Central States type is quite definite and flattens off early. This type is the significant one for floods and flood protection in the Miami Valley.

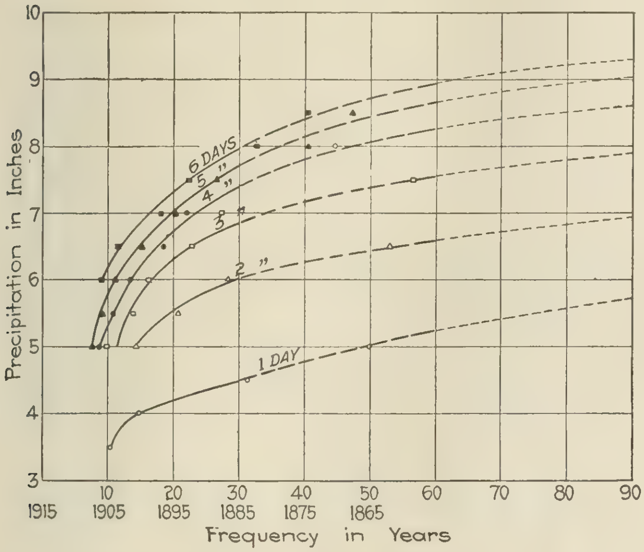


FIG. 6. QUADRANGLE FREQUENCY CURVES; THREE-DAY CURVES FOR MIAMI QUADRANGLE

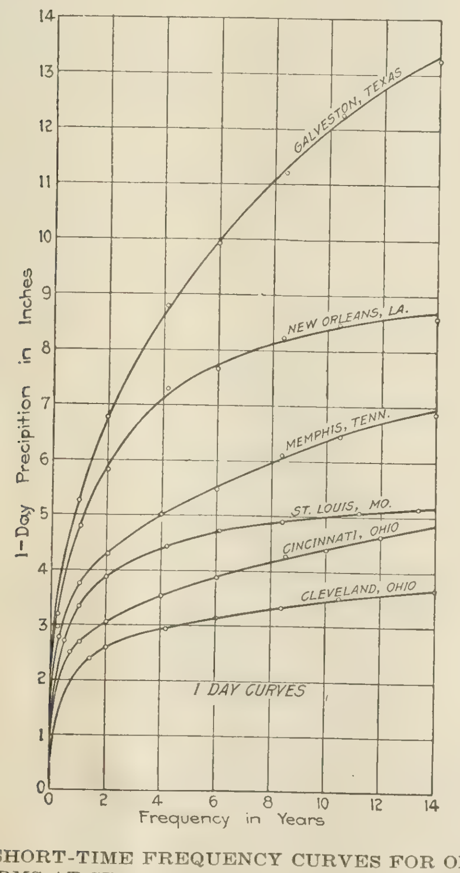


FIG. 7. SHORT-TIME FREQUENCY CURVES FOR ONE-DAY STORMS AT SIX STATIONS IN LOW-TRACK BELT

The method used for these curves gives slightly higher values than that used for Fig. 8, the latter being more correct. The 50-year one-day storm for Cincinnati totals 5½ in.

Long-Time Storms; Method B—It was desired to compute the intensity of the storm that would occur only once in 50 years and once in 100 years, on the average. For this purpose the sum of the record-years of all the stations in a quadrangle, as 360, was divided by 50. The quotient (7.2) represented a number of storms, say seven. Selecting the seven largest storms in the record of that quadrangle and averaging their intensities gave the average intensity of the 50-year storm. Similarly, averaging the four largest storms gave the intensity of the 100-year storm.

This was done for all the 133 quadrangles. The only limitation was that the record at a single station must be at least 10 years.

Fig. 8 gives the 100-year three-day storm-intensity map of the eastern United States, whose data were computed by the process described. These values are close approximations to the ultimate values, for storms of three-day concentration period. Comparison of 100-year and 50-year storms shows that the maximum is closely approached.

The average ratio of increase of the 100-year storm over the 50-year storm, as shown by these figures, is 12 to 15%. This means that the 100-year value is not far below the maximum. Projecting the 50- and 100-year values forward into the future along the curve of the type shown by Fig. 6, the most liberal allowance will give an ultimate maximum storm value about 10 or 15% in excess of the 100-year value.

Another Way of Summing the Experience of the Central Basin

A further development of the experience summation led to results that bring together the entire experience of the Central States. In this way, storm-incidence for very long periods of time could be studied, in spite of the fact that the records were for a short time only.

The area covered by this computation includes practically all of Illinois, Indiana, Kentucky and Ohio, and parts of Missouri, Iowa, Wisconsin, Michigan, West Virginia and Virginia—being the rectangle lying between 37° and 43° latitude and 81° and 91° longitude. There were records from 478 stations in this area, with record lengths ranging from 10 years to 73 years and averaging 15.8 years.

Fig. 9 shows the curves derived from these records. They indicate a slowly decreasing rise to a maximum, but a much slower rise than in Fig. 6 or 7.

The conclusions drawn from the curves were primarily applicable to areas as large as the entire Miami basin. To get values for the separate tributaries (with reference to the individual retarding basins), it was not thought desirable to attempt further mathematical deduction. The developed runoff curve (heavy full line in diagram at left (Fig. 2) was taken as applicable to the two large basins (Huffman and Taylorsville); a slightly higher curve (dash line) was drawn for the three smaller basins.

The Rainfall-Runoff Relation

The studies as described were studies of rainfall. But runoff is less than rainfall, in variable ratio. Does present or future variation of its ratio affect the Miami flood problem? Can higher runoff occur, so that a given rainfall will produce a greater flood?

The 1913 crest flow is estimated at 84% of the maximum rainfall. The drainage area is so widely agricul-

tural that even with bare ground and long rainfall a 100% rate was not reached. Future increase of runoff ratio by improved water-shedding property of the area was considered.

Most of the area is cleared, and its low portions are fully ditched. Tiling to replace ditch drainage is just beginning. Ditches give rapid surface runoff, but leave

FIG. 8. THREE-DAY 100-YEAR STORM MAP OF THE EASTERN UNITED STATES

The contours and figures represent the total rainfall of the three-day storm whose average period of recurrence is 100 years

the ground saturated. Tile drainage carries the water away much more slowly, but continues the process until the excess of water is removed from a 2-, or 3-ft. depth of soil, leaving a large temporary storage capacity. These reasons make it probable that extension of tiling will decrease the runoff ratio rather than increase it. The conclusion is confirmed by measurements of runoff from pumping drainage districts in Illinois.

The Seasonal Influence and Snow

While it was concluded that the runoff ratio cannot change for the worse, the chance that a great storm may find frozen ground was taken into account. In connection herewith, seasonal differences were studied attentively. Both rainfall and runoff vary with the seasons, but in inverse sense. The conclusion from a consideration of all the factors was that, with respect to long-time possibilities, the seasonal variations are largely compensatory.

Against the fact that in winter and spring the runoff ratio is greatest—with saturated ground and full discharge from the groundwater reservoir—there is the striking fact that winter storms are not only rare, but also less intense than summer storms. The curves of Fig. 5 show only the 1913 storm as coming in months of high runoff ratio. All the great storms in the area studied include only one other really great winter storm (Dec., 1895, Missouri, 8.78 in. in three days), but this occurred in a region of higher normal rainfall than Ohio.

The judgment of the engineers was that the differences between winter and summer storms and the possibility of frozen ground in late winter make it most reasonable to assume a runoff ratio about the same as that of 1913—

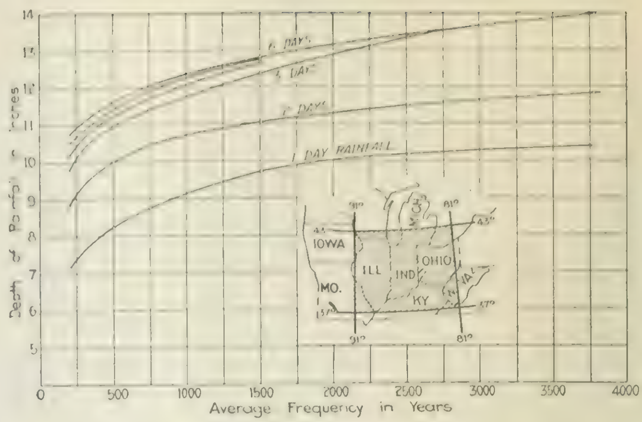


FIG. 9. AGGREGATE FREQUENCY CURVES FOR CENTRAL STATES BASIN

From records of 478 stations having an average period of record of 15.8 years. Curves show frequency of maximum rainfall

namely, 85 to 90%—and therefore to base all assumptions of flood flow directly on comparison with the 1913 flood.

Snow as an additive element was—after full consideration—left out of account. There is no record of a great storm that fell on snow-covered ground. The nature of the air movements that produce long-continued storms is incompatible with the presence of snow or ice, it is held.

Storms in Sequence, and Southern Storms

The soil storage in the Miami area during the summer season was very large. Careful experiments showed that it amounts to 2½-in. water depth. This factor constitutes a protection not only against the intense summer storms, but also against the distant chance that two great storms might follow in close sequence—a chance existing only under summer conditions. The soil drains rapidly enough so that in summer a 10-day interval between storms would suffice to prevent any large influence of the first storm upon the runoff of the second.

The tremendous semitropical rainfalls of the Southern States might suggest startling possibilities for the Miami Valley. The recent (July, 1916) Carolinas storm presents a serious picture, as see the three-day rainfall curves in Fig. 10 (see also the maps of progress of this storm

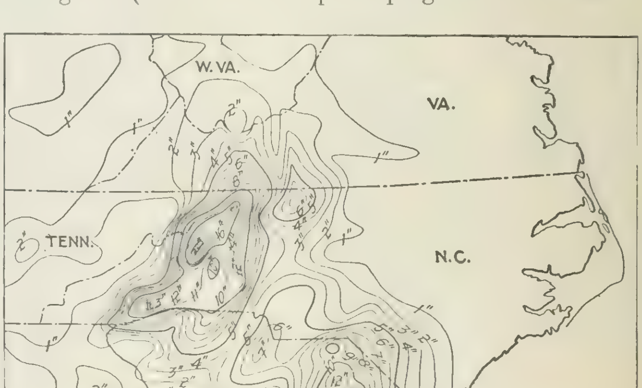


FIG. 10. THREE-DAY RAINFALL MAP OF THE CAROLINAS STORM, JULY 14 TO 16, 1916

printed in *Engineering News,* Nov. 9, 1916, p. 887). But the fact is that such storms cannot cross the mountain barriers; their main burden of cloudwater must discharge as they travel up the slope. The Carolinas storm, for example, showed a tremendous total—18 in. of rain in two days on a 500-mi. area—in North Carolina; yet on the landward side of the mountain ridge, but a few miles west, in eastern Tennessee, only 1 in. of rain fell during the same period.

The storm studies previously described comprise the operation of all causes, including those which can bring Gulf or West India storms up to the Miami Valley. The question of how much water such a storm can deposit near its place of origin, or in the coast states, is not pertinent. The important matter is how much it can bring to Illinois or to Ohio. These studies have already given the answer: Southwestern Ohio can never experience a storm runoff in three days greater than 9½ or 10 in., for an area equal to the Miami Valley.

The studies of rainfall and runoff have been carried out under the personal supervision of Arthur E. Morgan, chief engineer, and S. M. Woodward, consulting engineer; G. H. Matthes has taken charge of working up the rainfall data, and Ivan E. Houk has had charge of the runoff and rainfall measurements in the Miami Valley.

Large Concrete Water Tank Forms Part of Garage

By Herman Myers*

A reinforced-concrete water tank of somewhat unusual construction has recently been built as a part of the garage on the estate of Garret A. Hobart, Jr., Manchester Township, N. J. It forms the central ornamental tower to the garage buildings and the lower part, below the 30,000-gal. tank, is to be used as a chauffeur's room.

The tank is octagonal, having an inside diameter at the bottom of 14 ft. 4 in., this diameter continuing to a height of 12 ft. 8 in. where the vertical walls slant, making the inside diameter at the top 7 ft. 8 in. and having a depth of water at its center of 26 ft. 2 in. The vertical walls vary in thickness from 8 in. at the bottom to 6 in. at the top.

*With John Westerveld, General Contractor, Paterson, N. J.

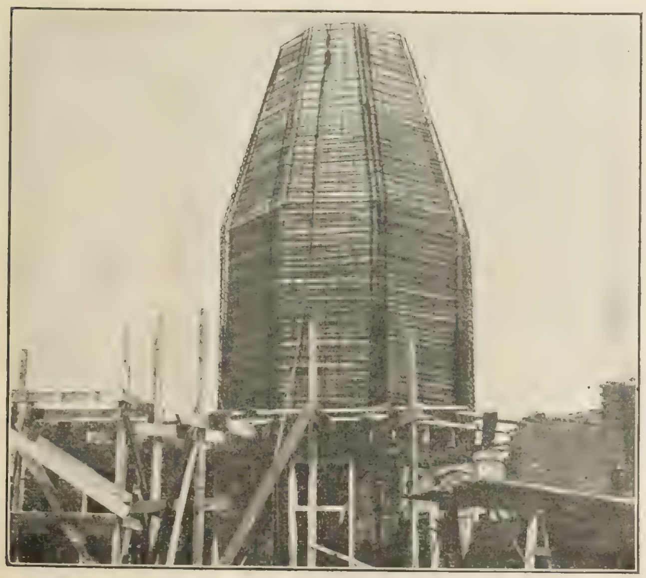


FIG. 1. VIEW OF TANK DURING CONSTRUCTION

The tank is supported by eight reinforced columns extending below grade to solid rock. Their vertical reinforcement comprises six 1-in. square corrugated bars in each column, four of these bars extending vertically to a height of 16 ft. The remaining two bars extend the full height of the tank projecting from the top of the walls, thus providing the necessary anchorage for the tank cover. The vertical reinforcement of the tank walls consists of ⅜-in. square corrugated bars 27 ft. long, placed 12 in. c. to c.

The horizontal reinforcement comprises ⅝-in. square corrugated bars placed 4 in. c. to c. and extending up to a height of 12 ft. 8 in., then ½-in. square corrugated bars placed 4 in. c. to c. extending to a height of 8 ft. 6 in., then ⅜-in. square corrugated bars placed 4 in. c. to c. for the remaining 5 ft. The floor of the tank is 18 in. thick and is of reinforced concrete and hollow tile.

The inside of the tank is covered with ¾-in. cement plaster waterproofed with "Truss-Con" waterproofing

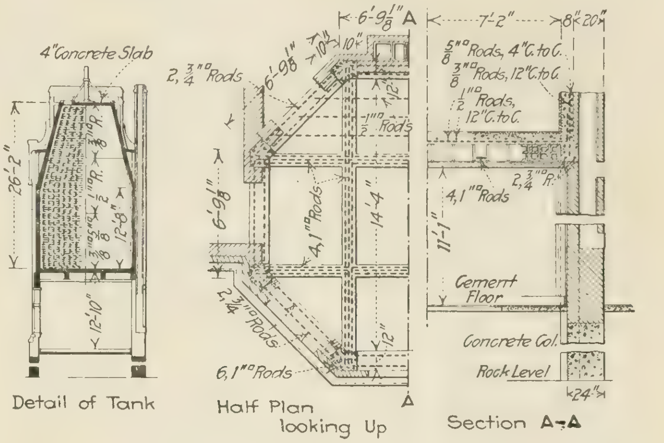


FIG. 2. DETAILS OF CONCRETE WATER TANK

paste concentrated, 1 part for every 36 parts of water, and the outside is covered with face brick matching the rest of the building. The sand was obtained from a pit about ½ mi. distant; quarried traprock of size to pass through a ¾-in. ring was obtained from a quarry about 1 mi. distant. The proportions of the concrete for the cover are 1 : 2 : 4, and for the floor and vertical walls 1 : 1½ : 3.

The cover of the tank is a 4-in. reinforced-concrete slab. the reinforcement consisting of ⅜-in. square corrugated bars 8 in. c. to c. both ways.

The design was made by and the work was done by John Westerveld, Contractor, Paterson, N. J.

Asphalt-Paving Statistics—Dec. 11, 1916, is the fortieth anniversary of the asphalt-paving industry in the United States. On that date in 1876 there was completed the first extensive asphalt pavement, on Pennsylvania Ave., Washington, D. C., from Sixth St. to the Treasury Building. This work was carried out with asphalt imported from the Island of Trinidad. The avenue was paved in accordance with ideas developed by E. J. de Schmedt, a Belgian chemist. Since 1876 the yardage of natural-asphalt pavements has increased from the 54,000 sq.yd. laid on Pennsylvania Ave. to the amount of about 200,000 sq.yd., or roughly the equivalent of 22,000 mi. of city streets, the larger part of which have been constructed with asphalt from the Island of Trinidad, according to the Barber Asphalt Co., which compiled the statistics.

Activated-Sludge Power Costs

By Gustav J. Requardt*

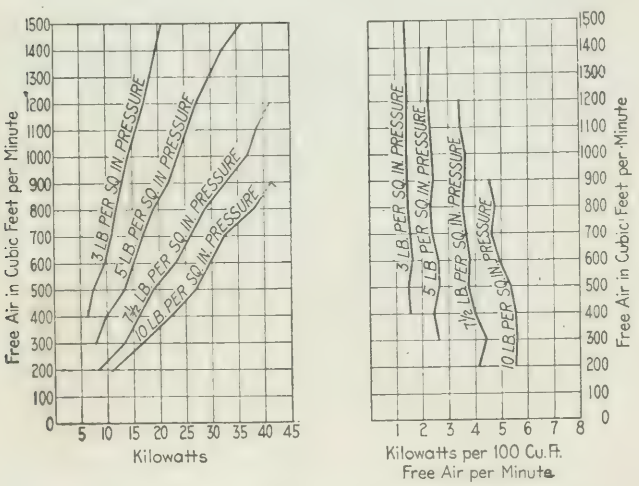
Given the amount of air delivered by a blower (requiring a definite amount of power for operation), the ratio of air to sewage necessary for the degree of treatment desired and the unit cost of power, it is a simple calculation to find the power cost for sewage treatment by the activated-sludge method. When many calculations are to be made at one time, the writer has found that much work may be eliminated by the construction and use of a set of curves in which all factors are considered to vary within limits suited to average conditions.

Ezra B. Whitman recently instructed the writer to draw up such a set of curves for use in his office, taking the relations between necessary power and delivered air from the catalogs of various air blower and compressor manufacturers. These curves are herewith presented. While data from only one manufacturer of air blowers (the Connersville Blower Co.) are given, it is a simple matter to plot on the same sheet the values as given for the several other makes of air blowers and compressors.

Construction of Diagrams

Fig. 1 is made by plotting as abscissas the power necessary to drive the machine, and as ordinates the corresponding free air delivered, there being separate curves for various air pressures. Plotting thus the information taken from the catalogs of the various makers, a quick comparison of efficiencies may be made.

Fig. 2 is made up from Fig. 1. The ordinates remain the same (free air delivered) while the abscissas are obtained by dividing the power by the corresponding volume of free air in units of 100 cu.ft. For example: At 5 lb. per sq.in. pressure a 22-kw. machine will deliver 900 cu.ft. of free air per minute; therefore, 2.4 kw. of power is required per 100 cu.ft. of free air per minute in a machine capable of delivering air at the rate of 900 cu.ft. per min. It is to be noticed that in the type of blower taken as an illustration for these curves the efficiencies but slightly increase as the machines become larger.



FIGS. 1 AND 2. POWER REQUIRED TO DELIVER FREE AIR

Fig. 1 (Left)—Power necessary to deliver compressed air with Connersville blowers. Fig. 2 (Right)—Power required to deliver 100 cu.ft. of free air per minute

*Assistant to Ezra B. Whitman, of Norton Bird & Whitman, Engineers, Chicago and Baltimore.

Fig. 3 is made by plotting as ordinates the kilowatts per 100 cu.ft. of free air per minute, and as abscissas the kilowatt-hours per million gallons of sewage, the radiating solid lines giving the various proportions of volumes of free air in cubic feet to volumes of sewage in gallons. The same radiating lines also give relations between sewage flow and volume of free air required for treatment. The relations between kilowatt-hours per million gallons of sewage treated and cost of power per million gallons are also plotted on this sheet, the radiating dotted lines representing the various unit costs of power.

The method of proportioning air supply to sewage flow, volume for volume, is far simpler, in the writer's mind,

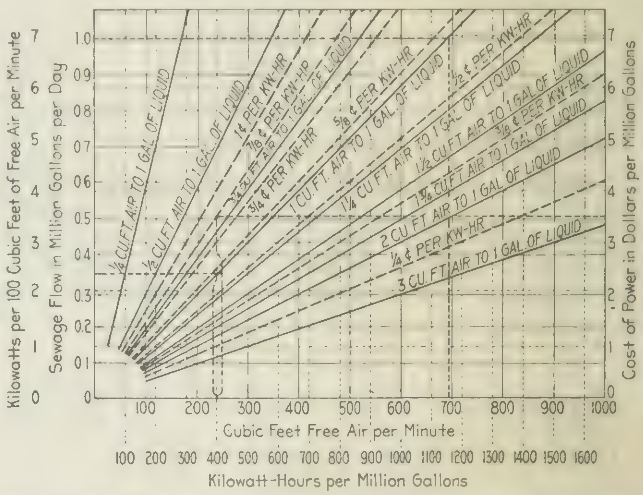


FIG. 3. RELATION BETWEEN SEWAGE FLOW AIR AND POWER REQUIRED IN ACTIVATED-SLUDGE PLANTS

1,000,000 gal. per day = 694 gal. per min.

than any other method. Some engineers prefer to state the volume of air supply to the area of tank surface per unit of time. This brings the dimensions of the sewage tank or container and the length of time of air treatment into the problem, where these elements do not belong; they can be much better handled in the actual design of the plant. It is well to remember, then, in using the curves, that *volume* of air supply is proportional to *volume* of sewage treated, irrespective of the size or shape of tank or of the length of time of air agitation and treatment.

How To Use the Curves

To illustrate how the curves are to be used, let us assume that the sewage of a city is to be treated by the activated-sludge method and that the cost of power is required. Assume that experiments on the sewage have shown that the necessary purification is obtained by applying 1 cu.ft. of free air per gallon of sewage; that the proper depth of tank requires air to be delivered at a pressure of 5 lb. per sq.in.; that current in the locality in question costs ⅞c. per kw.-hr. The sewage flow may be assumed at 1,000,000 gal. per day. It is to be noted here that, for larger flows, a straight-line relation holds between sewage flow and air required and that the air can be supplied by any number of blowers or compressors. Larger problems can thus be split down to smaller units and each solved separately.

With the elements above assumed having been determined, we are now ready to make use of the curves. Enter Fig. 3 at the ordinate for 1,000,000 gal. sewage flow per day and note where this ordinate strikes the radiating

solid line for 1 cu.ft. air to 1 gal. liquid, the abscissa at this point reading 694 cu.ft. free air per minute. This determines the size or capacity of air blower required. Now enter Fig. 2 at the ordinate for, say, 700 cu.ft. of free air per minute and note where it strikes the line for 5 lb. per sq.in., the abscissa at this point reading 2.4 kw. of power per 100 cu.ft. of free air per minute. Again using Fig. 3, note where the ordinate for 2.4 kw. per 100 cu.ft. air per minute strikes the radiating solid line for 1 cu.ft. air to 1 gal. liquid. The abscissa at this point reads 400 kw.-hr. per million gallons of sewage treated. Reading upward along this abscissa, note where it strikes the radiating dotted line for ⅞c. per kw.-hr. The ordinate at this point, toward the right-hand margin, reads $3.50 cost of power per million gallons of sewage treated, which is the result desired.

In the example given above, no recognition has been taken of the fluctuation of sewage flow as it reaches the plant. To apply to each gallon of sewage its proper volume of air, a detention chamber can be utilized so that the raw sewage may be passed into the agitation compartment of the activated-sludge tank at a uniform rate; or the capacity of the air-blower units can be figured upon the maximum or peak flows with the idea that separate units are to be shut down, one by one, as the sewage flow decreases.

Flow of Air Through Orifices Against Back Pressure

By B. S. Nelson*

The flow of air through orifices exhausting at atmospheric pressure has been studied and formulas have been deduced applicable to that condition, but there seem to be few data available as to the amount of air that will flow through a given size of orifice against a back pressure, with a definite initial pressure and final pressure.

Herein are given the results of an attempt to find an empirical formula to fit such cases. The formula found,

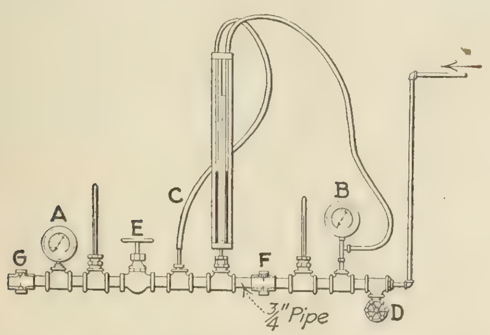


FIG. 1. APPARATUS USED FOR AIR ORIFICE EXPERIMENTS

while tried for a special case only—and perhaps it is a special case of some known formula and unrecognized as such—is interesting nevertheless for its simplicity and for the fact that it checks well for the whole range of the experiments.

The flow of air through an orifice against a back pressure is of interest in connection with the design of air nozzles for air-lift pumping from deep wells, and the experiments made had in view a formula applicable to cases where the orifice exhausts against a back pressure slightly lower than the initial or receiver pressure. It would also be useful for measuring air through an orifice in a pipe line where only a slight drop is desirable, as, for example, a meter.

The apparatus used, Fig. 1, was made up principally of standard ¾-in. pipe valves and fittings. The orifice plates were held between the two halves of the unions shown, which were faced in a lathe; a gasket was put on each side. The orifice plates were thin steel disks, $\frac{1}{16}$ in. thick, with several sizes of holes drilled and the burrs honed off on an oilstone.

The plates marked *F* (referred to as the measured orifices) were the subjects of the experiments the plates *G* being used simply as meter orifices to measure the air that had passed through *F*.

Three sizes of measured orifices were used—$\frac{1}{32}$, $^3/_{64}$ and $\frac{1}{16}$ in.—and the same three sizes of meter orifices were used. The object of having different sizes of meter orifices was, first, to best suit the discharge of the particular size of hole

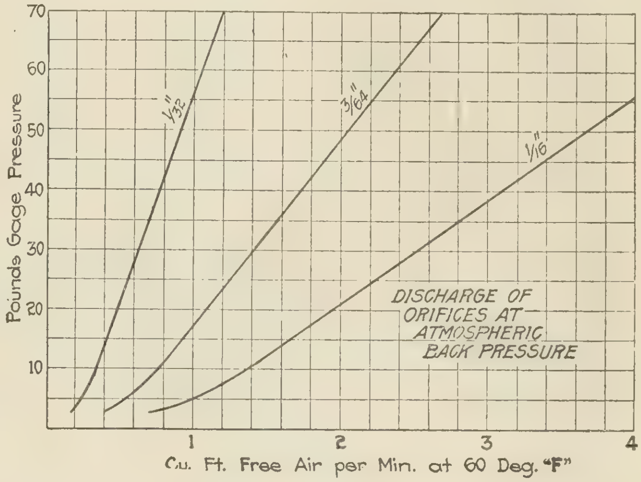


FIG. 2. DISCHARGE THROUGH ORIFICES AT ATMOSPHERIC BACK-PRESSURE

tested and, second, to check by taking readings on the same measured orifice with different meter orifices.

The object of the two thermometers shown was to make temperature corrections for the cooling due to expansion through the orifice *F*; but it was found that this drop was negligible, so the thermometers were not used.

Gages *A* and *B* were calibrated with a dead-weight tester, and corrections were applied to results. In order to measure the drop in pressure through *F* accurately, a mercury U-tube or manometer was used, graduated to tenths of inches and connected by tubing to each side of the orifice.

The apparatus was connected to a tank containing air at fixed pressure; by regulating the bypass valve *D* and the valve *E* any initial pressure and any drop desired through the orifice *F* could be obtained.

The tail pressure on the meter orifice *G* (which was of course different from either of the above) was an index to the amount of free air escaping to the atmosphere. This amount was the same that had passed through the measured orifice and was the result sought.

The air discharge was computed from the formula

$$W = \frac{0.53AP}{T}$$

where

W = Weight of air in pounds per second;

*7319 Panola St., New Orleans, La.

P = Pressure behind orifice in pounds per square inch absolute;
A = Area of orifice, square inches;
T = Absolute temperature.

As a matter of convenience the discharge at various pressures for each of the three sizes of meter orifices was plotted graphically, as shown in curves, Fig. 2.

By manipulating valves D and E a group of observations was made with a certain fixed pressure behind orifice F and several different pressure drops through it, the range of drop being as great as possible with the apparatus. This was repeated with several (usually four) different pressures behind F.

TABLE 1. SET OF READINGS TAKEN ON $\frac{3}{64}$-IN. ORIFICE, WITH $\frac{3}{64}$-IN. METER ORIFICE

Gage B, Lb.	Gage A, Lb.	Discharge, Cu.Ft. per Min.	Drop through F, Lb.
90	14.45	0.92	2.66
90	10.80	0.80	1.97
90	7.80	0.68	1.48
75	32.50	1.48	7.52
75	26.40	1.28	5.66
75	18.0	1.02	3.59
75	11.0	0.81	2.17
60	31.2	1.44	8.40
60	25.9	1.27	6.50
60	19.4	1.07	4.57
60	12.0	0.84	2.65
45	26.0	1.27	8.46
45	21.5	1.13	6.50
45	15.9	0.96	4.42
45	9.8	0.76	2.66

The size of meter orifice was chosen by preliminary trial, to best suit the range of the particular set of observations; at the end of the experiment one or two readings were repeated with a different meter orifice as a check. It was found that these checked readings agreed within about 5%, which was deemed close enough for practical purposes.

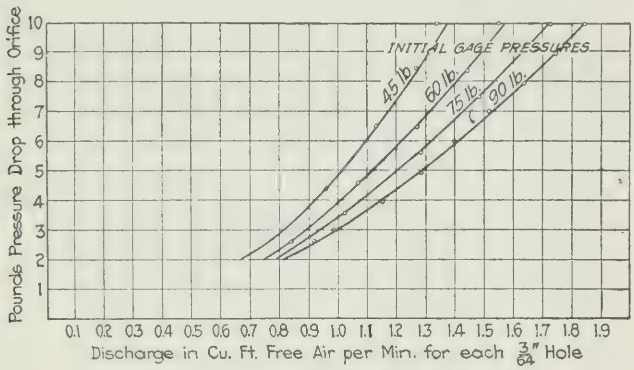


FIG. 3. POINTS IN THESE CURVES WERE PICKED FOR PLOTTING CURVES IN FIG 4

In order to reduce all the readings to convenient form, it was necessary to plot the actual readings graphically and then from these curves pick points from which to plot a second set of curves with the desired ordinates and abscissas. The curves in Figs. 3 and 4 illustrate this for one size of orifice, and similar curves were made for each size of orifice.

Each of the curves in Fig. 3 is for a separate initial pressure P and is plotted with drop in pounds through the orifice F as ordinates, and cubic feet of free air discharged per minute per hole as abscissas.

From these curves points were picked to plot the final curves in Fig. 4, which are in more convenient form. For instance, if one wanted to know the number of $^3/_{64}$-in. holes to put in an air-lift nozzle, with 80-lb. receiver pressure and 5-lb. drop through the nozzle: Using Fig. 4, start at 80 lb. on the ordinate line, run over to the curve for 5-lb. drop and down to the abscissa line; we get 1.24 cu.ft. of free air per minute discharged per hole, which divided into the total quantity of air gives the total number of holes required.

It was suspected from the smoothness of these curves that there probably was a formula that would fit every point in the range of the experiments. The discharge should vary directly as the area of the orifice and as some power of the two variables—initial pressure and drop through the orifice—and there would also be some constant K.

It was assumed from other air formulas that this power of the initial pressure was the ½ or square root, and us-

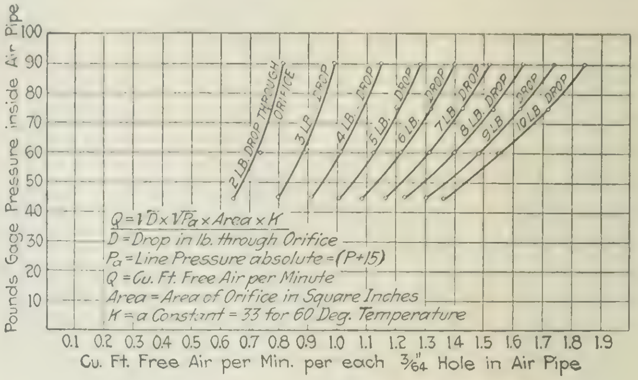


FIG. 4. FINAL OR WORKING CURVES

ing this in a number of random readings it was found that in each case the same power of the drop in pressure (the ½ power) held good. The result was the formula

$$Q = D^{\frac{1}{2}} \times P^{\frac{1}{2}} \times A \times K$$

where

Q = Discharge in cubic feet free air per minute;
D = Drop through orifice in pounds per square inch;
P = Initial pressure, pounds absolute;
K = Constant whose value is 33 for 60° F.

The value of K was obtained by computing it from points taken from the curves in Fig. 4. These points, to obtain a good average, were selected for drops of 2, 4, 6, 8 and 10 lb., with initial pressures of 45, 60, 75 and 90 lb., making a total of 20 values for K for each orifice or 60 for the three. A set of these values is given in Table 2. The average for the $\frac{1}{32}$-in. orifice was 33.1, for the $^3/_{64}$-in. was 32.3, and for the $\frac{1}{16}$-in. was 33.6, or an average for the three of 33.

TABLE 2. VALUES OF K CALCULATED FROM POINTS TAKEN FROM CURVES IN FIG. 4

Orifice	Line Pressure, Lb. Absolute	Drop in Pounds through Orifice 2	4	6	8	10	
$\frac{1}{32}$-in.	60	32.1	31.4	32.4	33.2	33.6	
	75	31.9	29.5	32.7	33.0	33.5	
	90	31.6	30.0	33.0	33.2	33.2	
	100	33.1	31.8	31.1	33.1	32.8	Average, 32.3
$\frac{3}{64}$-in.	60	34.3	34.1	33.2	32.4	32.4	
	75	34.3	33.8	33.0	33.0	33.9	
	90	33.6	33.0	32.8	33.6	33.1	
	100	32.2	32.5	32.2	32.6	32.8	Average, 33.1
$\frac{1}{16}$-in.	60	34.9	33.7	32.6	32.2	32.0	
	75	34.7	33.4	33.0	32.9	33.2	
	90	34.2	33.5	33.4	33.6	33.9	
	100	33.6	33.4	33.6	36.2	34.2	Average, 33.6
General average							33.0

The formula has not been checked for ranges beyond those on the curves, nor has the value of K been found for temperatures other than 60°, because these served the purpose for which the experiments were made. It would be interesting for someone with proper laboratory facilities to extend the experiments for greater range of drop and to find the temperature coefficient.

Rebuilding with Permanent Surface Old Macadam Roadways

First-Prize Road-Building Article in the "Engineering News" Prize Contest

By Charles A. Carruth*

The division office of the New York State Department of Highways, Rochester, N. Y., started in 1909-10 some very interesting and profitable experiments, in the resurfacing of worn-out macadam roads, with permanent or semipermanent pavements.

These experiments, the first of their kind under the Commission of Highways, were begun under former Division Engineer M. W. Wilbur and consisted of resurfacing macadam roads, built years previous, which on account of changed traffic conditions were becoming expensive to maintain as waterbound macadam. The resurfacing materials used were brick, bituminous concrete (Topeka and "Amiesite"), rock asphalt, McClintock's concrete and brick cubes, "Rocmac," and bituminous macadam, penetration method.

As some of the above-mentioned materials have stood the wear of greatly increased traffic for six or seven years with practically no maintenance, they may be considered under the head of permanent paving, if there is any such thing.

The writer, while not connected with this work in any official capacity but as employee of the Department of Highways at Rochester, was quite familiar with the construction employed, and being a fellow employee of G. G. Miller, engineer in charge of this work, has gathered from him the data necessary to complete this article.

This resurfacing was done on highways leading out of Rochester, two of the roads beginning at the city line and carrying heavy mixed traffic.

Brick on Renovated and Grouted Macadam

The description of the resurfacing of the Scottsville Road, No. 63, follows: The road was built in 1902-03 of waterbound macadam 6 in. thick. The soil is heavy clay with quicksand pockets. This road carries a heavy farm traffic. There is a brickyard located near it, the output of which is carted to the city by teams and motor trucks. Much extensive and expensive repair was continuously necessary, especially near the city line. In 1910 a contract was let to resurface ¾ mi. of this road with a 4-in. brick pavement, using the macadam as a base.

An edging 8 in. thick and 10 in. deep, of second-class concrete, was first constructed to the required line and grade. The macadam was scarified. This material was forked over to allow the dirt and fine material to go to the bottom. New stone of ¾ to 1¼ in. in size was added to make up the necessary grade and crown. The stone was grouted with a mixture of 1 part cement to 2½ parts sand, rolling was carried on while the grout was being applied, until grout flushed to the top of the stone. This base was allowed to set for a few days. A sand cushion 1½ in. thick was then made, the brick placed and grouted with a 1:1 mixture. The cost of brick, cushion, edging and preparation of the base was $1.60 per sq.yd. of brick pavement; to this cost may be added 24c. per sq.yd. to cover widening of embankment, graveling shoulders, drives, etc., not always needed for such resurfacing work. The brick and edging gave a paved width of 17 ft. This road went from 1910 until last year without any repairs, except to shoulders.

As the grouting of the brick was done late in the fall, it must have been injured by frost, for in the spring of 1911 much of the grout came out, causing cobbling of the brick at the joints. In 1915 the pavement was swept clean and an application of Tarvia B, 0.2 gal. per sq.yd., was applied and covered with a thin coat of clean sharp sand. While this tar treatment has worn off in some places, the joints are filled flush and the cobbling has been stopped. There are no cracks or breaks in the pavement, and it should be good for many years with very little maintenance.

Macadam Resurfaced with Bituminous Concrete

The resurfacing of Monroe Ave., Road No. 94, was done in 1910. This road was built in 1902-03 of waterbound macadam and carries heavy mixed traffic. There is a brickyard ½ mi. from the city line. One mile was resurfaced, using two kinds of asphalt and types of bituminous concrete. The old macadam was scarified lightly and brought to proper crown and grade with new stone ¾ to 1¼ in. in size, then well rolled and filled. One-half of a mile was built of Topeka type, using California asphalt. The pavement on this section was 2 in. thick when finished. The mixture was made in a semiportable Koehring paving plant.

The proportion per batch was 2,070 lb. sand, 1,035 lb. stone chips up to ½ in. in size, 945 lb. stone dust and 450 lb. asphalt. Some cracks and pot holes developed in this section; these have been repaired by patrolmen at a cost of about $10. This section is wearing thin, but is good for several years with careful maintenance.

After the old macadam was scarified and brought to grade as described above, the second section, nearest the city, was resurfaced by first laying a binder coat of stone and asphalt 1 in. thick. On this was placed a mixed top, 2 in. thick when rolled, using the following proportions for each batch: 500 lb. sand, 300 lb. stone chips up to ½ in. in size and 88 lb. of Trinidad asphalt, the thickness of surface being 3 in. finished. This section is in excellent shape and has had no maintenance in the past six years. Each type cost $1.24 per sq.yd., including the work on the base, the cost being high on account of the small amount contracted for.

The resurfacing of East Ave., Road No. 5, in 1909 with "Amiesite" at a cost of $1 per sq.yd. was another successful experiment, and after seven years with practically no maintenance it is in fair condition today.

These experiments have stood the ravages of modern traffic conditions and are good for some time to come, showing that with the proper selection of resurfacing materials much can be done to utilize the many miles of macadam that has done its duty as a road surface.

*County Assistant Engineer, New York State Highway Department, Rochester, N. Y.

Concrete Paving for Small Levee on the Wabash River

By George C. Graeter*

The Wabash River levee in Sullivan County, Indiana, was constructed in 1895 at a cost of $71,500. Starting at the Illinois Central R.R. embankment at Riverton, Ind., it extends down-stream along the left bank of the river for 8 mi. (in which high land serves as a levee for about 1 mi.) and then about 1.6 mi. up the right bank of the Prather drainage ditch, which is the new channel of Busseron Creek. This levee was constructed to protect some 12,000 acres of farm land from the floods of the Wabash River and Busseron Creek, and in connection with three drainage systems (two county and one private) it virtually reclaimed 7,500 acres of bottom and marsh land that now has an average market value of $100 per acre.

The earth used in the original construction of the major portion of the levee was a friable sandy loam, and the

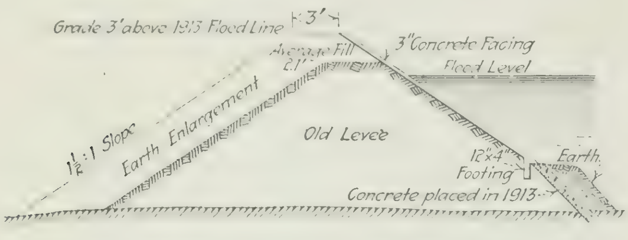


FIG. 1. WABASH RIVER LEVEE, SHOWING EARTH ENLARGEMENT AND CONCRETE FACING

levee as a whole (and more particularly the upper end) has never afforded adequate protection from high water, erosion, seepage or burrowing animals.

In 1904, $4,000 was spent for repairs; in 1912, $18,300 for repairing breaks; and in 1913, $14,500 for repairing breaks and for placing concrete at the riverside toe of slope on 12,500 ft. of the upper end. Maintenance has cost $14,000 (or about $650 per year), most of this being spent in digging out ground-hog and mole burrows and mowing the levee. Thus the cost of repair and maintenance up to 1916 was over 66% of the first cost of construction, and the levee was still in poor condition.

In March, 1916, the Levee Committee (which is elected by the owners of the majority of the land in the levee district) retained the writer to make an investigation of the existing levee and prepare plans for its repair and improvement. The cross-section, Fig. 1, shows the plan adopted. It consists in enlarging the cross-section with material added to the top and the land side and in protecting the river slope by a 3-in. concrete facing or revetment.

The concrete extends for about 12,500 ft. from Riverton to a sand ridge. It consists of 199,100 sq.ft. of facing and 154.3 cu.yd. of footing. The earth enlargement on this upper section averages 231 cu.yd. per 100-ft. station; on the next 20,000 ft. beyond this ridge it averages 163 cu.yd. per station, and then for about 6,700 ft. the average is 240 cu.yd. per station. The total enlargement, including a short stretch of relocated levee, amounts to 88,000 cu.yd.

*Civil Engineer, Sullivan, Ind.

On the section that is being concreted the earth enlargement (28,890 cu.yd.) is being put up by a reconstructed Monighan dragline excavator, shown in Fig. 2. The remainder of the enlargement is being constructed with teams, using slip and wheeled scrapers. The shrinkage allowance was 20% for dragline work and 10% for team work. The top and land slope of the levee were plowed, and all stumps and brush were removed before placing the fill for the enlargement. The Levee Committee provided borrow pits without expense to the contractor. The specifications permitted material to be taken on either side of the levee, but required it to be taken on the river side where possible. No material was to be taken within 22 ft. of the toe of the old slope, and new pits were not allowed to be more than 3½ ft. deep.

Concrete Facing for Levee

The concrete facing for the river slope is a 3-in. slab extending from the top of the levee to the old concrete toe and having behind this toe a 4-in. footing wall 12 in. deep, as shown. This footing is formed as part of the slab. Joints are provided at intervals of 20 ft. by ½-in. wood strips 3 in. deep. Each 20-ft. section is cast as a single slab. When the concrete of two adjacent sections has set, the wood partition strip is removed and the ½-in. space filled with concrete without any attempt to bond the old and new concrete.

The concrete was composed of gravel taken from the bed of the river and having not less than 30% or more than 40% of sand retained on a 64-mesh screen. The coarse aggregate had a maximum size of 1½ in. and was specified to contain not over 5% (by weight) of loam

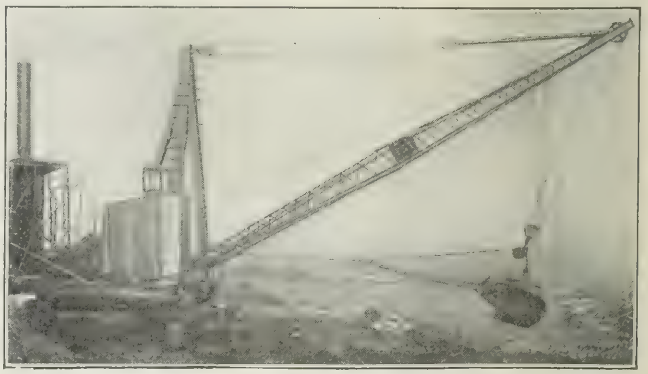


FIG. 2. DRAGLINE EXCAVATOR FOR LEVEE ENLARGEMENT

or other foreign matter. The concrete was moderately wet, proportioned 1 : 6, and was made in a batch mixer of 7-cu.ft. capacity. An addition of 10% (by weight) of hydrated lime was provided for by the engineer, but not admitted by the Levee Committee.

Deposits of suitable sand and gravel were found on the river side of the levee at the lower end of the concrete work and on a bar in the river at about the middle of the work. For the upper end, the coarse aggregate was hauled from a pit about ½ mi. inland from the levee.

The river face of the levee was grubbed and cleared of all vegetation, and any marked depressions were filled with earth. A plow furrow was run at the back of the old concrete toe, and the trench for the footing was dug with tiling spades. The slope was then dressed, wetted and tamped with a 75-lb. rammer. The mixer was placed

at the toe of slope, and the concrete was shoveled by hand from the discharge platform, as shown in the upper view, Fig. 3. The wheeled cart, holding 6 cu.ft. of aggregate, was pulled up the runway by a wire cable on a drum operated by the engine of the mixer.

The footing was placed first, and then the facing was placed from the toe of slope and footing upward. The surface of the concrete was smoothed with the backs of the shovels, no striker or templet being used. The method of work could be improved by using a mechanical elevator to place the concrete on the slope. Within an hour after the placing of the concrete it was covered with a 1-in. layer of earth, which was thoroughly sprinkled the next day. This covering, which assisted the curing of the concrete, was left in place for about ten days in

FIG. 3. CONCRETE FACING FOR THE WABASH LEVEE

The upper view shows the mixer plant and gang, and a stretch of finished concrete slope. The lower view shows the finished concrete partly covered with earth. The level rod is being held at the level of the flood line of 1913

hot weather. The lower view in Fig. 3 shows the concrete slope partly covered with earth. This view is at Riverton, and the rodman is holding the level rod on a bench mark set at the flood level of 1913 (El. 442.68).

Numerous superficial cracks have appeared in the finished facing. This was expected, most of them being in the upper part of the slab, where the concrete is laid on the new earth enlargement. They are probably due to settlement and rapid setting and are not increasing in size or number.

It is expected, however, that the facing will prevent erosion, reduce seepage and prevent burrowing animals from working through the levee, and that in combination with the earth enlargement it will enable the levee to withstand extreme high water without damage to itself or to the land behind it.

Contractors and Cost

The contract was awarded to M. R. Polk & Co., of Oaktown, Ind., at 20c. per cu.yd. for earth enlargement and $6.60 per cu.yd., or practically 6.1c. per sq.ft., for the concrete. The concrete work was sublet to Charles Ridgway, of Carlisle, Ind, and was done by him at a cost of $5.12 per cu.yd., or about 4.75c. per sq.ft. The pay was $2 per 9-hr. day for labor and $4 for teams. The cost of this concrete work was distributed as follows:

	Cost per Cu.Yd.
Cement (cost, hauling and storing)	$2.52
Gravel (purchase price, stripping pits or deposits and hauling)	0.55
Labor and superintendence (preparation of slope, wetting and surfacing, also mixing, placing and finishing concrete)	1.87
Equipment and repairs (counting 50% depreciation and including gasoline for mixers)	0.18
Total cost per cu.yd.	$5.12

The record run for the mixer and gang shown in Fig. 3 was about 3,500 sq.ft. (or about 32 cu.yd.) in one day. An inspector in the employ of the Levee Committee and under the direction of the engineer was on the work all the time. Semimonthly payments were made to the general contractor, on the engineer's estimates, 20% being retained until the completion of the contract.

Shaft Sinking by Freezing Revived in England

Shaft sinking by the freezing process was carried on at least as far back as 1862, but of late years the method has fallen into disuse. The *Engineer* describes a recent application of the freezing process at the new Llay Hall colliery, Wrexham, England. Both the upcast and the downcast shafts—270 ft. apart—which were originally giving off large feeders of water, have been carefully treated and the brickwork made quite dry. The only water that now has to be disposed of comes from the underground workings. The difference in level between the stratification of the two shafts is about 40 ft., corresponding to a dip of 17° from No. 2 to No. 1.

At first, two foreshafts were sunk 12 ft. deep and 31 ft. in diameter and lined with brickwork. Concrete was placed on the bottom after inserting straight vertical guide tubes for 25 bore holes distributed around a circle 26½ ft. in diameter. In the upper strata the holes for the freezing tubes were bored by the rope method, but in the lower and harder ground percussion apparatus operated by a steam cylinder was used.

The cold necessary for freezing the water-bearing ground was applied by two distinct groups of machines. The pipes and valves were arranged so that either group of machines could operate on either shaft or on both simultaneously. Each included a belt-driven ammonia compressor with an independent horizontal steam engine having cylinders 16¾ in. in diameter and 30-in. stroke. A solution of calcium chloride was used as the freezing liquid and was caused to circulate between the refrigerators and the freezing tubes by means of two plunger pumps. The brine pipe between plant and shaft was insulated with hair felt.

The ground was frozen to a depth of 231 ft. in the first and 235 ft. in the second shaft. The diameter of the pit shafts after lining is 18 ft.

Placing Ornamental Concrete on Steel Frame

By Harry L. Dean*

SYNOPSIS—Details of costs and methods in placing concrete casing on rather complicated steelwork of a new elevated station just completed for the rapid-transit enlargement in New York City.

The Pelham Parkway station of the White Plains Ave. elevated extension to the old subway lines of New York City is located at the intersection of White Plains Road and Pelham Parkway and about 1,000 ft. north of the Bronx and Pelham Parkway entrance to Bronx Park. It was decided to enchance the appearance of this structure and make it an ornamental concrete station in harmony with the pleasing surroundings of this section, with landscape forming a beautiful foreground for the architectural effects of an ornamental structure.

The station is of the mezzanine type, the tracks being carried over a mezzanine story at each end of the structure in through girders to allow sufficient headroom for the mezzanine floor. The structure is 550 ft. long over nine spans, symmetrical about both center lines. The steel columns for the track girders are situated in the street, and the station platforms are carried on cross-frames framed into steel lattice sidewalk columns and lattice wall girders, both incased in concrete.

The principal features of the exterior architectural effects are the massive appearance of the structure, the

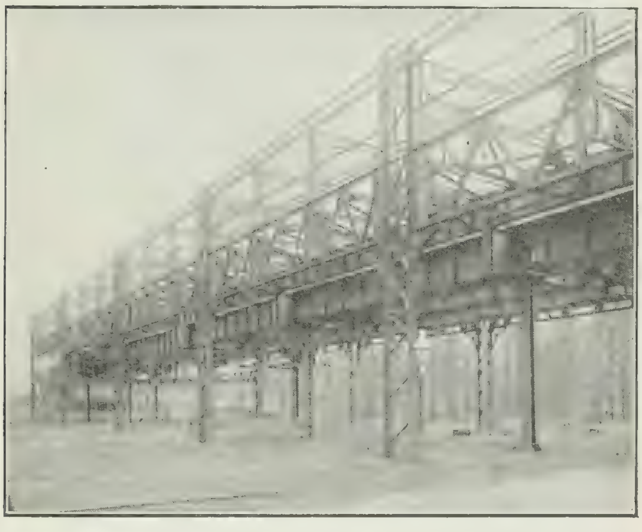


FIG. 1. STEEL FRAME OF PELHAM PARKWAY STATION, WHITE PLAINS ELEVATED R.R.

unbroken and graceful lines of the walls and brackets merging into the columns, the exterior being set off with inlaid colored tile to add brightness to the natural concrete finish of the structure. The entire appearance of the station harmonizes with the purpose of the structure, and its severe structural character shows an expression of strength, magnitude and dignity, the keynote being simplicity in every respect, with the costly architectural treatment reduced to a necessary minimum.

Well-seasoned timber of an accepted grade was used for the formwork. The forms were cut and laid out on the ground in sections and then hoisted up to be set in place. The contractor used an all-electrical equipment, which included an electrically operated saw.

Great care was employed in erecting the forms and keeping them in proper alignment during the entire process of construction. Owing to the fact that the concrete is open to view, experienced carpenters were

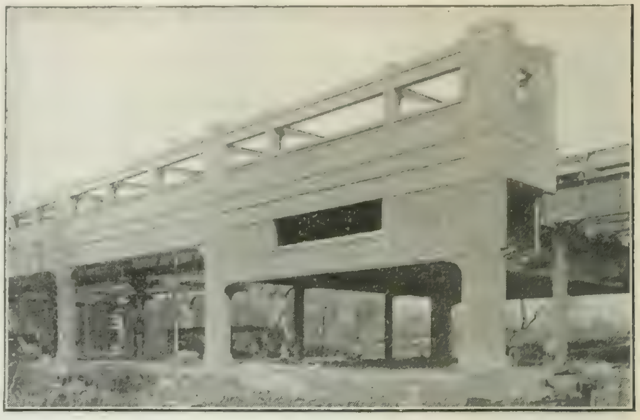


FIG. 2. CONCRETE CASING JUST AFTER FORMS WERE REMOVED

employed, as only first-class help could handle efficiently this quite complicated piece of work.

It developed that the sludge oil which was used for the forms stained the concrete, and therefore oiling the forms was later eliminated. Instead, the forms were made wet, previous to pouring the concrete, by playing a hose upon them freely. This proved an effective means of making the forms water-tight, preventing the cement from leaking through the cracks in the wood and making a smooth uniform surface finish, thus reducing the rubbing of the surface to a minimum. All steel was incased in a No. 8 gage steel-wire mesh before pouring the concrete. Steel mesh was also used in the concrete as a reinforcement in the walls between lattice girders.

Many sections of the forms were used a number of times, due to the symmetry of the structure, and this constituted a considerable saving in the material and labor. Nevertheless, as may be seen from the cost table, the cost of the formwork was high as compared with the unit price of concrete.

Mixing and Placing of Concrete

A wooden elevator tower 110 ft. high, made up of verticals of 4x4 in. and 2x6 in. single bracing, with a system of suspended chutes from a movable skip on the tower, adjusted to chuting conveniently different sections of the structure, was used to distribute the concrete. An electrically driven Ransome concrete mixer of ½-yd. capacity was employed, and a gravity hopper delivered to and emptied the concrete in the chutes. On account of the 120-ft. roadway crossing at the center of the site of the station it was necessary to move the tower and mixer to the north end of the station after the south end was completed.

*Engineering department, Public Service Commission, New York City.

The concreting operation required one hoist runner, one man for emptying the mixer, throwing in the cement and directing the gang at the mixer, three men to handle the sand and stone, one man on the tower to regulate the flow of the mix, and one man at the end of the chute to distribute the concrete. The contract called for a 1:2:4 mix, with broken stone graded to ¾-in. size. A somewhat richer mix was used with enough water in it to compensate for the difficulty and in some cases the utter impossibility of spading the concrete. Notwithstanding this difficulty in spading, the concrete was of a uniform dark appearance with no honeycombing visible and a rich cement layer at the surface, which fact was disclosed when the bush hammer was applied. There were no signs of separation of the ingredients of the mix, although the drop of the concrete from the hopper through the chutes was about 100 ft. in some cases and the mix had water in abundance.

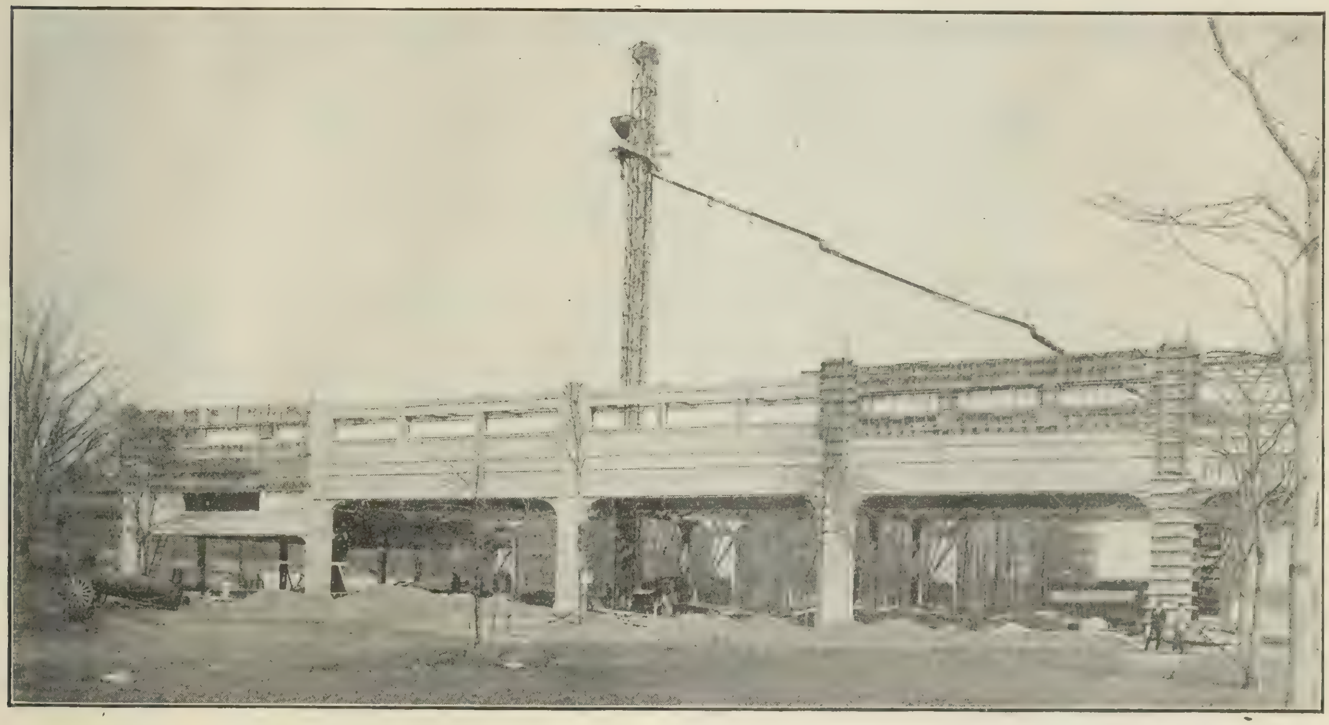


FIG. 3. METHOD OF PLACING CONCRETE IN ELEVATED STATION

It may be of interest to mention that the wooden tower resisted very well a gale of 90 mi. per hr.

Expansion Joints of Special Design

An interesting and quite unusual feature was the method of providing expansion joints for the walls. The structure has four expansion joints located at the same bents as the expansion joints for the track girders. Layers of cork board were used as a separator to keep the concrete apart from the face of the steel lattice column, to provide enough play for the expansion of the walls and at the same time remedy the defect in the outer appearance of the joint. The layers of cork were 1¼ in. thick at the longitudinal expansion joint and ½ in. thick between the bracket and the bottom face of the wall.

The detail of the expansion joint provides a 2x8-in. bearing plate under the wall, resting upon a 4-in. half-round for a smooth longitudinal movement, the shear being cared for by the bracket. The platform girders have slotted holes in the bottom flange to facilitate the movement of the platform and wall in one mass. At the surface the layers of cork were finished off with a neat cement wash, and no visible discord in appearance could be detected.

In what way this expansion joint will prevent the scaling off of the concrete and the possible cracks in the concrete, due to the vibrations of the structure in the case of the train impact, will be shown in the future. In connection with this it may be said that the writer has observed the following: The impact of the crane erecting steel about 2,000 ft. away from the station has set the entire steel framework of the station vibrating so as to be noticeable by the writer (standing on a cross-girder) and has thrown out the bubble of the level about six divisions on the tube. This was observed after all the steel was riveted and just before the concrete operations began. It is certain that the weight of the concrete will materially lessen the vibrations, and the expansion joints will undoubtedly take up some of the vibration. Nevertheless, it may not prove sufficient entirely to prevent cracks and even scaling off some of the concrete.

Waterproofing the Track Floors

The track floors over the mezzanines at each end of the station were waterproofed, the membrane method being used. The process consists of covering the concrete with three plies of a coal-tar saturated burlap in the following manner: The surface of the concrete, when dry, was smoothed off and mopped with asphalt pitch, heated to about 300° F. A ply of burlap was then put on and pressed down carefully upon the mopped surface into the still hot pitch to assure a bond between the ply and the concrete. The surface of the layer was again mopped and a second ply adjusted. This ply was mopped and a third ply put in place and carefully pressed down. The joints overlap each other by a minimum of 1½ ft., care being taken to break joints.

A surface coat of concrete 3 in. thick was then applied and a slope given to each section of the floor, draining through pipes provided in the steel to each end of the floor and thence to the sewer. As a precaution against the water finding its way along the webs of the girders, a 2-in. recess sloping down to the waterproofing fabric was provided and filled with an approved elastic cement compound. This patented compound, costing about $19 for a 129-gal. barrel, is a dark colored elastic mastic that never hardens. Its function is to fill up the spaces provided between the concrete and steel and eventually fill up all voids in the joints that may occur when the vibrations of the steel will tend to break off the bond

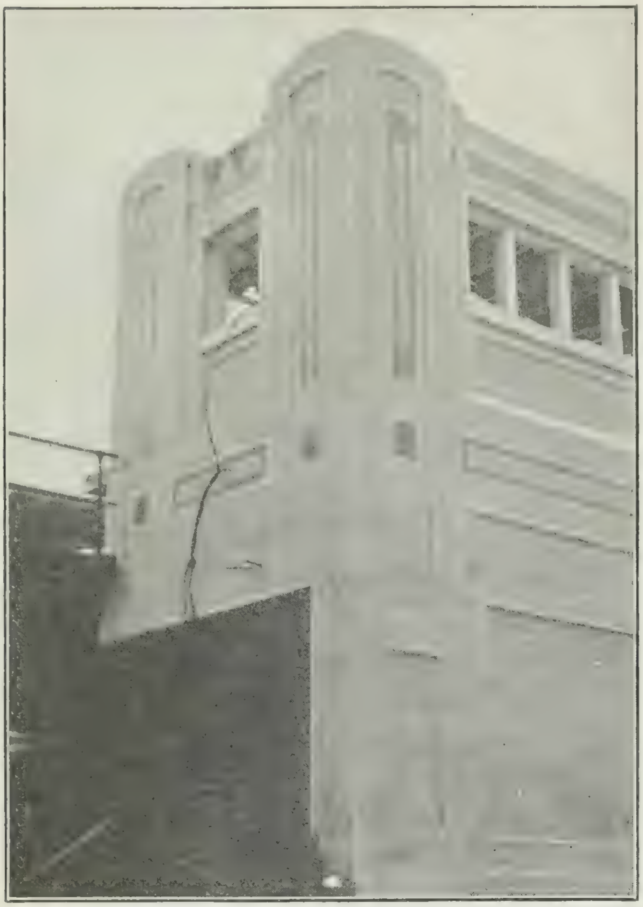


FIG. 4. NEAR VIEW OF CORNER OF STATION, SHOWING ARCHITECTURAL DETAIL

between the girders and the concrete, thereby making the point waterproof.

Borders $1\frac{1}{2}$ or 2 in. wide around the windows and panels will be cement washed and rubbed, and the rest of the surface with the exception of the recesses for the inlaid tile will be of a natural concrete finish and tooled, a bush hammer being used. The inlaid colored tile will form diamond and square combinations that will give a pleasant appearance and at the same time break the tendency to expand in one direction. A well-made, wet-pressed, noncrazing tile will be used. This decoration will somewhat soften the austere appearance of the structure.

Costs of Applying Concrete Incasement

The main feature of interest is the cost of concrete work on this station, and especially the cost of the formwork. Although the work was performed quite efficiently, which is the observation of the writer, the item of the formwork was nevertheless $7.73 per cu.yd. of concrete placed, which may be reduced about 47c., allowing for the value of the lumber available for further use after the completion of this job, making the net cost of the formwork $7.26 per cu.yd.

COST OF PLACING CONCRETE ON STEEL FRAME

Total Amount of Concrete Placed = 1,690 Cu.Yd.

				Total	Cost per Cu.Yd
Lumber, nails, tie-rods, wiring and cost of building and moving the tower				$3,000.00	$1.78
Formwork					
Class of Work	Rate of Pay, per Diem	Number of Days Worked	Total		
Foreman	$5.00	196	$980.00		
Carpenter	4.50	1,520	6,840.00		
Carpenter's helper	2.50	895	2,237.50		
			$10,057.50	10,057.50	5.95
Overhead Charges					
Superintendent	$6.00	92	$552.00		
Timekeeper	2.00	160	320.00		
Watchman	1.50	225	337.50		
			$1,209.50	1,209.50	.71
Concrete Work					
Laborers	$1.50	1,280	$1,920.00		
Hoist runner	4.75	54	256.50		
Mason	4.00	85	340.00		
Mason's helper	2.50	16	40.00		
			$2,556.50	2,556.50	1.52
Concrete Materials					
Material	Unit Cost	Total Materials Used	Total		
Cement, per bbl.	$1.35	2,390	$3,226.50		
Sand, per cu.yd.	.65	435	282.75		
¾-in. stone, per cu.yd.	.90	870	783.00		
			$4,292.25	4,292.25	2.54
Grand total				$21,115.75	$12.50
Appraisal of lumber used for another construction job				800.00	.47
Net total				$20,315.75	$12.03

The price per cubic yard of concrete, as shown in the accompanying table, is $12.03. To this should be added 10% profit for the contractor and 5% insurance charges, or $1.80, making a total of $13.83. The price asked by the contractor in his successful bid was $11 per cu.yd., thereby resulting in a net loss to the contractor of $2.83 $\times$ 1,690 = $4,782.70. This loss was successfully offset, however, by the prices obtained for the steel, wire-mesh, surface-finish and tile work.

It may be of interest to mention that this contract for the concrete was sublet at the beginning of the undertaking for a price of $8 per cu.yd., for constructing the forms, supplying the cement, sand and stone and placing the concrete, all lumber, wires, nails, bolts, etc., and overhead charges being supplied by the Oscar Daniels Co. The subcontractor continued operations from June 28, 1915, to Oct. 12, 1915, after which date he was forced to retire, realizing a big loss of money due to the incompleted work. At the failure of the subcontractor to fulfill the requirements, the Oscar Daniels Co. continued and successfully completed the entire project.

The cost data were compiled from strict accounts of all the labor performed and materials supplied from the day of the beginning of the work to the day it was completed.

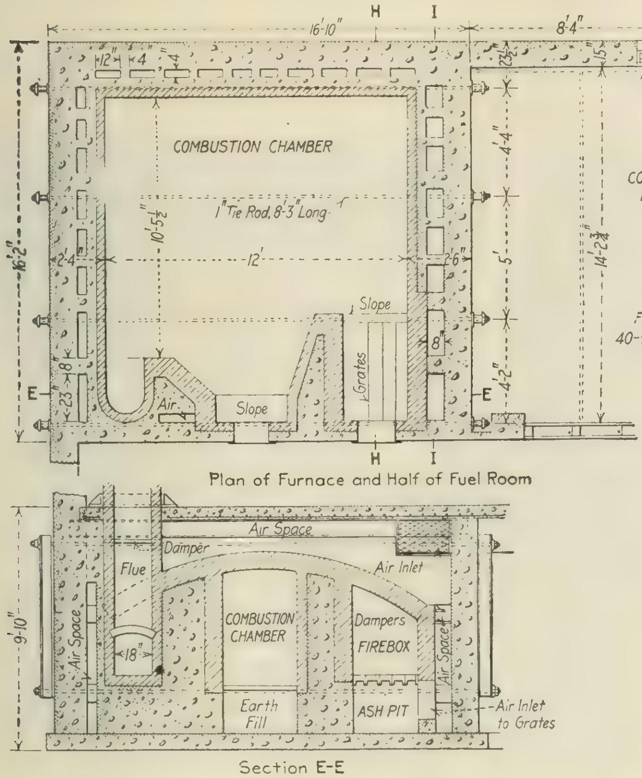
The work was done under the supervision of the Public Service Commission, George Paaswell, assistant engineer in charge. The writer was in close connection with the engineering and supervision of construction.

The Cost of Freight Cartage in city streets is to be the subject of investigation by the United States Census Bureau. It will be the object of the inquiry to determine what part the cost of carting goods to and from the railway station plays in the high cost of living.

Dutch-Oven Garbage Incinerator, Mason City, Iowa

By Robert F. Gayton*

A garbage and refuse incinerator consisting of two ten-ton dutch-oven-type units was recently put in use at Mason City, Iowa. Each unit is 12x12 ft. in plan by 4½ ft. high, inside. Figs. 1 and 2 show the details and general arrangement of the furnaces. The tops of the furnace form the floor of the second story. The second story covers but half the building and is the driveway and charging space. The building is 32x50 ft. in plan, built of tile, with a pebble-dash outside finish. The roof has a steel frame and is covered with red asbestos shingles.



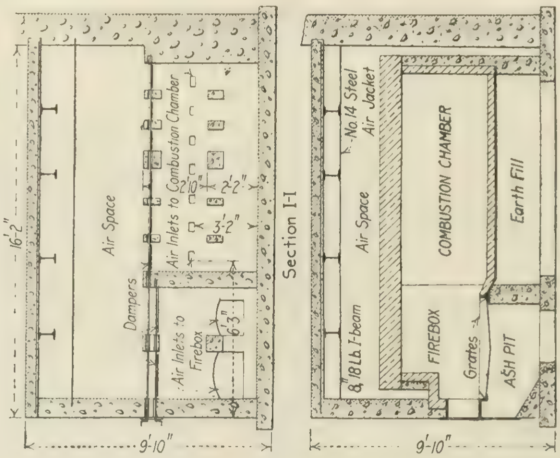


FIG. 1. PLAN AND SECTIONS OF GARBAGE INCINERATOR UNIT, MASON CITY, IOWA

The furnaces were built under a patent (U. S. No. 1,107,615) held by Jones Bros., Macon, Ga. The flues are arranged to give a preheated air supply, so that 60 lb. of the average mine-run bituminous coal is expected to reduce one ton of city-run garbage. This city-run garbage consists of kitchen wastes, commercial wastes—including tin cans and bottles—all carcasses, and night soil. The process is odorless at 1,000° F. and higher. The furnaces reach this temperature one-half hour to an hour after the fire is started. The process is also smokeless. The ash is approximately 10% of the garbage bulk and from 5 to 7% of its weight. The smokestack, lined with firebrick, is 18 in. in diameter and 40 ft. high.

When the test of the crematory was made, several tons more garbage was consumed than the guarantee called for.

The refuse-collecting wagons dump directly into the furnace (Fig. 2). By the use of the underslung wagon a load is dumped in three minutes. It is rarely necessary to raise the temperature in the furnaces higher than 2,200° F.

*Assistant City Engineer in Charge of Construction, Mason City, Iowa.

The furnaces are in continual operation day and night. Each two weeks it is essential to completely burn out a furnace to clean out the flues, which is a simple matter.

The cost of the incinerator complete was $12,000. As a matter of interest it may be stated that these burning units can be installed singly, in pairs or in any number necessary in accordance with the quantity of waste material to be consumed.

In connection with the incinerating plant there will be completed in February, 1917, sewage-treatment works consisting of Imhoff tanks and sprinkling filters. The cost of the entire system, including the incinerator, will be approximately $160,000.

FIG. 2. CHARGING AND STOKING FLOORS, MASON CITY GARBAGE INCINERATOR

The Cleveland Municipal Electric Station, which was completed in July, 1915, with a capacity of 20,000 kw., is to be increased 50% in capacity by the purchase of a 10,000-kw. generator, to be delivered in thirteen months. The price of the generator is $112,500, and it is to be paid for from the plant's earnings.

Sciotoville Bridge Erection Is Well Started

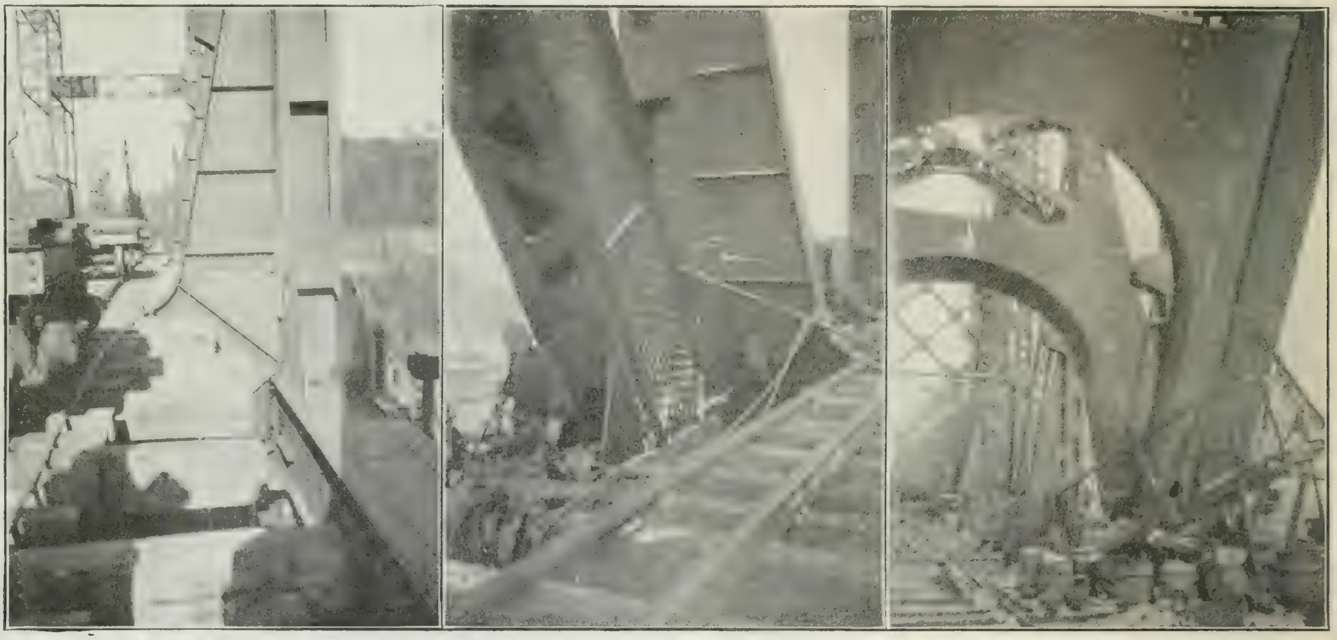
An unusual bridge-erection problem is being handled in the construction of the Sciotoville Bridge over the Ohio River for the Chesapeake & Ohio Northern R.R., which has been designed and is being executed under the direction of Gustav Lindenthal, Consulting Engineer, the McClintic-Marshall Co., of Pittsburgh, being the contractors. The unusual feature is the bending of the truss members during erection in such direction and amount as to bring all members into precisely straight condition when the completed bridge is loaded to half its live-load capacity. The object is to eliminate secondary stresses, not only in the chords but also in the web members. Something similar was done in the new Quebec Bridge, but in simpler manner on account of the numerous pin connections. The Sciotoville Bridge has riveted joints throughout.

The erection program is based on full and precise calculations covering the deflections in every stage of erection, the stresses in all members, the influence of raising or lowering any point of support, the angular relations of the triangle members, and the forces that must be applied to bring the members together.

The bridge comprises two 775-ft. spans continuous over the middle pier—a structure virtually of new type for America, and the largest structure of its type ever attempted. It was shown by general drawings in *Engineering News* of July 8, 1915, p. 61. The original feature of U-shaped floor-beams, whose upward-extending legs are held at the top by the sway-bracing strut, thus securing both stiffness and reduced floor-beam moment, was there shown by a drawing. These floor-beams in erected position are seen in the view, Fig. 1, herewith. They are field-spliced a short distance above floor level, the upper parts being built integral with the posts. This splice was drilled to templet in the shop, except for the splice cover on the inner flange, which was drilled in the field.

The views show the Ohio span, which is erected on falsework; the Kentucky span is to be cantilevered out from it for a length of 165 ft., will there land on a steel temporary bent, and 155 ft. farther will land on a second bent, 155 ft. north of the Kentucky end pier. On account of the deflections of the trusses as the erection progresses, and the necessity of avoiding both undue stress in the truss members and excessive concentrations of load on the falsework posts, the truss will be jacked up several inches at these temporary bents as soon as it reaches them.

Similar jacking is done on the Ohio span previously, the truss being jacked up successively at three points, as it reaches them, in order to free the falsework on which it rested up to that time and thereby allow this falsework to be pulled, which will eliminate a large part of the danger from drift in an unexpected flood.



FIGS. 1 TO 3. ERECTION VIEWS OF THE SCIOTOVILLE BRIDGE

Fig. 1—Floor-beams and lower post sections set; gantry being raised for truss erection, Nov. 1. Fig. 2—Main panel point (L 16). Fig. 3—Portals over the center pier.

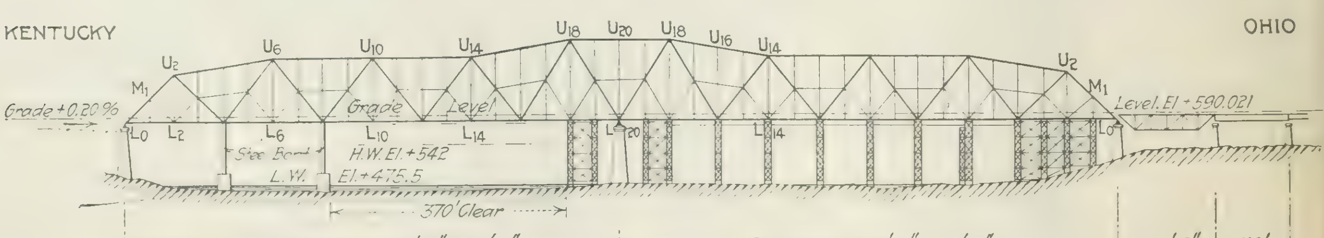


FIG. 4. SKETCH OF ERECTION FALSEWORK

The diagram Fig. 4 is reproduced from an erection sketch. The description of the erection procedure is based in part on a statement prepared by Paul L. Wolfel, Chief Engineer of the McClintic-Marshall Co.

Timber falsework is used to support the floor at every second panel point of the Ohio span, and plate girders from the approaches are used to span between them to carry the intermediate joints. At every second falsework bent (that is, every main triangle point) steel columns are built in, on separate footings, to carry the truss load. Screw-wedge jacks of 250 tons capacity on the timber bents (Fig. 7) allow for adjustment of height. Pin bearings are placed on the steel columns, allowing space for jacking up the truss by hydraulic jacks (Fig. 6).

The Ohio-span floor was first laid, by gantry traveler proceeding from L 0 Ohio, to L 20, the center pier, and on to L 18 Kentucky. Then working back, the traveler placed the lower chord. Immediately the splices of the chord were riveted. Then the chord was jacked and lowered at its various bearings, to deflect it into a curve of such shape as to allow the web-member connections to be made most easily. This curve is at its maximum about 1½ in. above the true level line, and at L 0 Ohio is about 8 in. below level.

The gantry being now built to the height necessary for truss erection, and the lower sections of the posts placed and spliced to the floor beams and chord, the work on the trusses was started at the great triangle over the center pier, and is progressing toward the Ohio bank. To erect the cantilever work of the Kentucky span, a creeper traveler was erected on the top chord of the L 20, U 18 O, U 18 K triangle in the latter part of December.

In the erection of the web members and top chord, none of the joints will go together without forcing, as they were laid out to fit the true truss diagram when stressed under full dead- and half live-load (3,000 lb. per lin.ft. per truss, full live-load being equivalent to about 6,000 lb. per ft. per truss). The web diagonals in general require to be bent by upward pulling with the tackle of the traveler, until drift pins can be entered in the joint, and then the connection must be forced into full matching position by drifting of a kind that will tend to put a slight reverse bend into the member.

To connect the posts, large vertical forces are required, for which purposes a special jacking rig has been built, to be clamped around the post near the top.

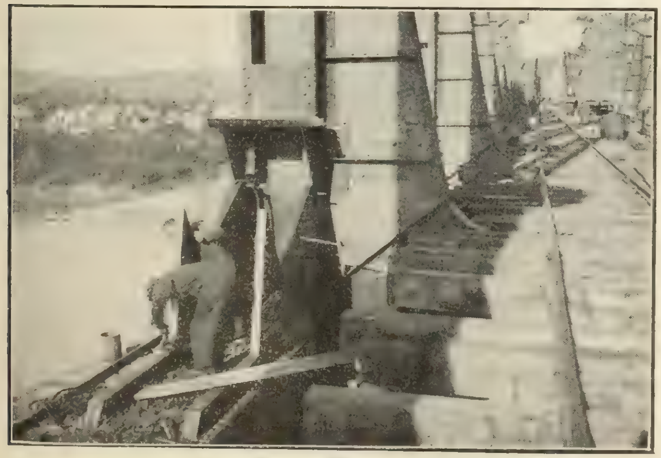
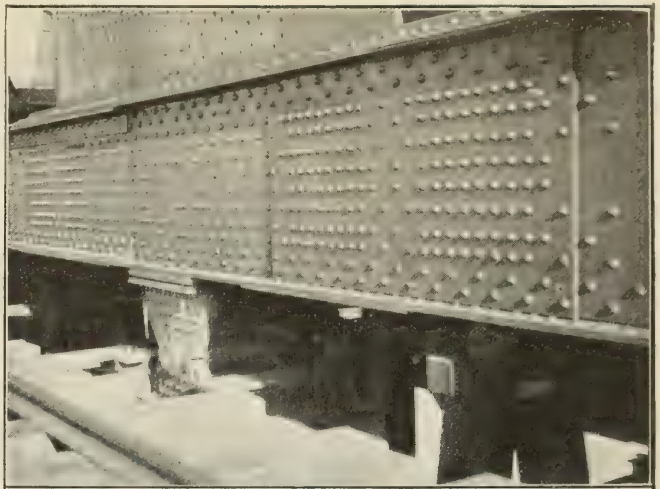
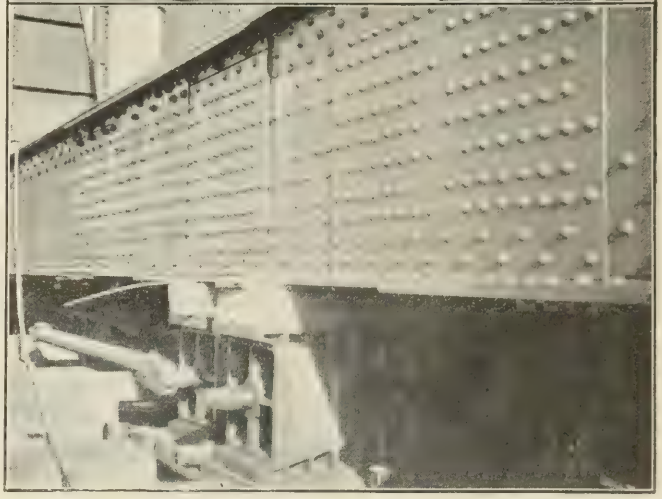


FIG. 5. THE U-FLOOR BEAMS SEEN FROM THE CENTER PIER; GUSSETS OF L 20 AT LEFT





FIGS. 6 AND 7. PIER SUPPORT AT MAIN PANEL POINT AND WEDGE JACK AT INTERMEDIATE PANEL POINT

A steel post is built in the falsework under each truss at the four main panel points

The Ohio span will be jacked up at L 12, L 8 and L 4 successively, to free the falsework. The jacking loads range to 400,000 lb.; the greatest load on the falsework columns will be about 1,300,000 lb. Finally, the Ohio end will still be 8.1 in. low and will have to be jacked up with 1,926,000 lb. to proper level, which will allow the 16-in. end rollers to be inserted and will free the last of the falsework columns.

Hydraulic jacks of 200 and 500 tons capacity are provided for the jacking; they will utilize pressures up to 4,000 lb. per sq.in.

Jacking the Kentucky span on the bents at L 8 and L 4 will require somewhat larger forces than above noted, and the final jacking at L 0 Kentucky will require a force of 2,337,000 lb. and a 16-in. raise.

At the end of December the trusses are erected from L 18 Kentucky to L 16 Ohio. The creeper traveler is in place on the Kentucky top chord and is taking down the falsework at 18 and 19 Kentucky. The gantry is proceeding with erection of the Ohio span. When L 12 Ohio is reached, the truss will be jacked. Shortage of labor has caused some delay, especially in riveting. The chord splices and large connections have 1¼-in. rivets, which demand skilled riveters.

R. T. Robinson is Resident Engineer for the consulting engineer. A. Toohey is superintendent in charge of erection for the contractor.

Notes from Field and Office

Diagram for finding column sections—A shaft-sinking record—Slide-rule for regearing water meters—Concrete pond curb good after 10 years—Small shield makes good record

Column Sections Quickly Found by Novel Diagram

By H. G. Nevitt*

The column formula of the American Railway Engineering Association is

$$p = 16{,}000 - 70\frac{l}{r}$$

where p is the unit load on the column, in pounds per square inch; l is the unsupported length of the member, in inches; r is the radius of gyration of the section, in inches. If P be the total load in thousands of pounds and A the sectional area in square inches, then

$$P = \frac{p}{1{,}000}A = \left(16{,}000 - 70\frac{l}{r}\right)\frac{A}{1{,}000}$$

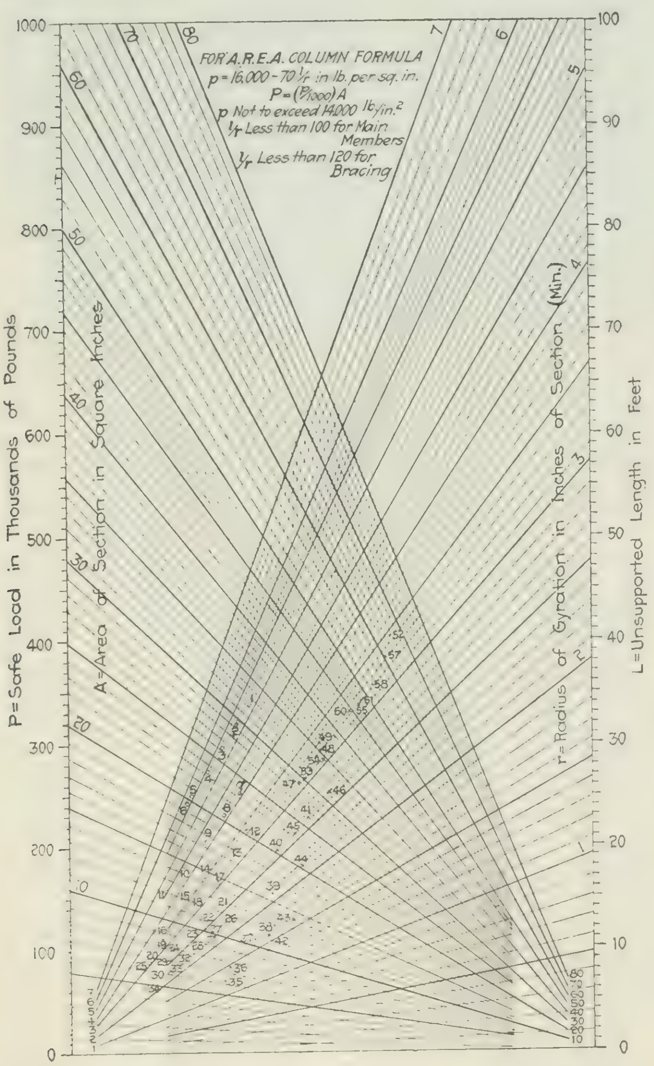
Of the four quantities to be considered, P and l are determined from the conditions of design. It then remains to choose a section for which r and A exactly satisfy the above equation, or in practice give a loading $\frac{P}{A}$ equal to or less than the allowable p. In addition, any other requirements demanded by the specifications or conditions of design, such as the limiting value of the ratio $\frac{l}{r}$, must be satisfied.

In the diagram, scales for P and L (L is length in feet, l is length in inches) are laid off on parallel vertical lines. Between these is a system of coördinate lines, radiating from the two initial points, representing the quantities A and r respectively. Hence any point between the scales for P and L has definite coördinates, or corresponds to a set of values for A and r. The property of the diagram is that a straight line between the points on the scales corresponding to P and L, respectively, passes through all the points whose values of A and r satisfy the equation with the value of P and L chosen. Hence, knowing P and l, a value of A can be assumed and the necessary value r read, or vice versa.

Evidently, any column section can be represented by a point, for it has a particular A and r. And if this point lies on the line through P and L, it gives the intensity of stress allowed by the column formula. If above it, the intensity will evidently be less than the allowable, and greater if below. Hence in brief:

Directions—Lay a straight-edge between the points on the scales for P and L. If the point whose A and r are

*Engineering Department of H. L. Doherty & Co., 60 Wall St., New York City.



A NOVEL STRAIGHT-LINE DIAGRAM FOR DETERMINING COLUMN SECTIONS UNDER A. R. E. A. FORMULA

LATTICED CHANNEL COLUMNS

No.	Depth, In.	Wt. per Ft., Lb.	B. to B., In.	No.	Depth, In.	Wt. per Ft., Lb.	B. to B., In.	No.	Depth, In.	Wt. per Ft., Lb.	B. to B., In.
1	15	55		13		30		24		13.75	
2		50		14		25	7	25		11.25	5
3		45	9½	15		20		26	7	19.75	
4		40		16		15	7½	27		17.25	
5		35		17	9	25		28		14.75	4
6		33	10	18		20	5½	29		12.25	
7	12	40		19		15		30		9.75	4½
8		35		20		13.25	6	31	6	15.5	
9		30	7½	21	8	21.25		32		13	3½
10		25		22		18.75	4½	33		10.5	
11		20.5	8	23		16.25		34		8.0	4
12	10	35									

PLATE AND ANGLE COLUMNS

No.	Web, In.	4LS	No.	Web, In.	4LS	2PLS
35	6x¼	3 x2x¼	47	12x⅜	6x4x⅝	14x ⅜
36	8x¼	3½x2½x¼	48	12x⅜	6x4x7/16	14x ½
37	8x5/16	4 x3x5/16	49	12x½	6x4x½	14x ½
38	8x⅜	4 x3x⅜	50	12x½	6x4x9/16	14x ⅝
39	10x⅜	5 x3½x⅜	51	12x⅝	6x4x⅝	14x ⅝
40	10x⅜	6 x4x7/16	52	12x⅝	6x4x⅝	14x1⅛
41	10x½	6 x4x9/16	53	14x⅜	6x4x⅜	14x ¾
42	12x¼	4 x3x5/16	54	14x⅜	6x4x½	14x ⅜
43	12x⅜	4 x3x⅜	55	14x½	6x4x⅝	14x ⅝
44	12x⅜	5 x3½x½	56	14x⅝	6x4x⅝	14x ¾
45	12x⅜	6 x4x½	57	14x⅝	6x4x⅝	14x1
46	12x½	6 x4x11/16				

those for the section considered lies on or above the line, the intensity of stress will be equal to or less than that allowed by the formula, and the section may be used if desired.

Example—$P = 170{,}000$ lb., $L = 30$ ft. Then any one of sections 9, 12 and 41 will be safe, and we use 9, which is two 12-in. by 30-lb. channels latticed, as having the smallest area.

Combined bending and compression may be treated in exactly the same manner if we use instead of P the quantity $\left(P + M\frac{n}{r^2}\right)$, where M is the bending moment in inch-pounds and n is the distance to the extreme fiber of the section in inches. This, of course, necessitates a solution by trial, which is without difficulty.

Method of Plotting Diagram

The following is the method of plotting a similar diagram for any column formula of the straight-line type. The theory is omitted for the sake of brevity, but is comparatively simple.

Assume the formula adopted as

$$p = X - Y\frac{l}{r}$$

the quantities being defined as before and X and Y being the coefficients in the formula.

Then: (1) Lay off on parallel lines the quantities P and L to any desired scales; (2) construct the coördinate lines for A so that they pass through the zero point of the L scale and intersect the P scale at the points $P = AX$; (3) construct the coördinate lines for r so that they pass through the zero point of the P scale and intersect the l scale at the values $l = \frac{X}{Y}$.

For convenience, on the A and r coördinates plot known sections for reference, although A and r may be read directly from the diagram and a suitable section selected if desired.

A disadvantage of the diagram is that a slight inaccuracy is introduced by unequal shrinkage of the paper. This is usually negligible. Another disadvantage is the limitation of accuracy by size. This objection is small here and can be entirely overcome by the use of different diagrams for different classes of work, as building columns and bridge upper chords.

Advantages of the diagram are: Speed of computation, combined with all accuracy usually necessary; compactness, as compared to tables; ease and simplicity of construction and use. Graphical comparison of the weight-efficiency of different sections, when the points are plotted on the diagram. For example, the latticed-channel columns have their metal better distributed than the plate-and-angle columns.

Shaft Sunk 252 Ft. in 31 Days

What is claimed to be a world's record in shaft-sinking was made by the Crown Mines in its No. 14 shaft, located in the Bovysers Reserve on the South African Rand. According to A. Cooper Key in the *Engineering and Mining Journal*, in the 30 days of September and the first day of October, this shaft was sunk 246 ft. and 6 ft. respectively, totaling 252 ft. It is circular, 21 ft. 6 in. diameter before bricking, 20 ft. inside lining.

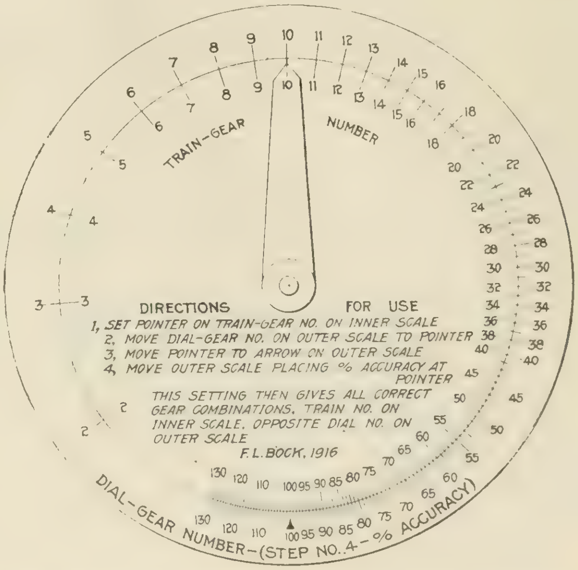
The sinking was done with the aid of 30 natives, working 90 shifts. Five Ingersoll-Rand machines were used per shift. To break the 9,120 tons of rock excavated, 67 cases of gelatin were consumed. This rock was hoisted in a 3-ton bucket, the hoisting being done by one steam engine connected with two boilers.

The previous sinking record was made by the Modder Deep Levels in April, 1912, when 234 ft. was sunk in one of the twin shafts. This shaft had three compartments, two measuring 5x6 ft. and one 6x6 ft. The Modder Deep beat the record created a month earlier in the southeast shaft of the Modder Government Gold Mining Areas by the narrow margin of a foot. This, in turn, was an advance from the 213 ft. of the Modder Deep constituting the previous record. Previously the best record was that of the Brakpan Mines, made as far back as July, 1907.

The 1912 records, now surpassed, were made at a depth of 2,000 to 2,500 ft., whereas the total depth of the Crown Mines new shaft is about 1,000 ft.

Slide Rule for Regearing Water Meters

A slide rule devised for the use of nontechnical employees of a water-works in computing combinations of change gears was described and pictured in *Engineering News*, Oct. 26, 1916, p. 800. The same scheme has been employed by the originator, F. L. Bock, Assistant Engineer,



SLIDE RULE FOR REGEARING WATER METERS

Distribution Section, St. Louis Water Works, in a circular rule that is more compact, more easily made and more convenient to use. As shown in the accompanying sketch, it consists of two concentric disks, the outer edge of the inner one and the inner edge of the outer one cutting the numbered radial lines. A rotating pointer takes the place of the pointer or hair-line rider of the straight rule. The new rule is used as directed in the sketch: it is first required to know the number of teeth on the old gears and the accuracy of the meter with them.

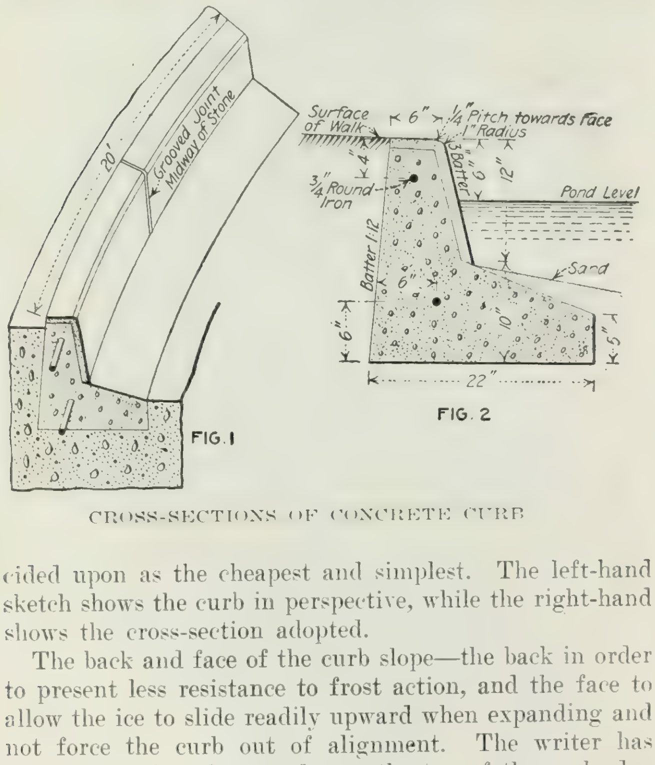
Concrete Curb of Park Ponds Uninjured After 10 Years

By Howard Lathrop*

Wading and skating ponds were built in the public parks of Fall River, Mass., varying from about ¼ to 1 acre of water surface. The margins were not regular curves connected by tangents, but a series of irregular curves with no straight lines whatever. Above the water line was a strip of sand with about a 1 in 10 pitch and 2 ft. wide, and surrounding this strip of sand was a macadam walk, both extending entirely around the ponds.

The wave action, when a strong wind blew, caused the sand and then gradually the walk to wash down and scatter, resulting in a very ragged margin.

Some form of curbing was necessary to confine the water to its original limits. To cut a stone curb to fit the series of irregular curves and set it to withstand frost action and ice pressure would have entailed considerable cost, inasmuch as each stone would have to be cut on a curve to fit its special position, and probably no two stones would be alike. Consequently, a concrete curb was decided upon as the cheapest and simplest. The left-hand sketch shows the curb in perspective, while the right-hand shows the cross-section adopted.



CROSS-SECTIONS OF CONCRETE CURB

The back and face of the curb slope—the back in order to present less resistance to frost action, and the face to allow the ice to slide readily upward when expanding and not force the curb out of alignment. The writer has seen the ice forced up and over the top of the curb, due probably in a great measure to the heavy vibration caused by hundreds of skaters gliding over ice having less than 1½ ft. of water under it. A foundation of cinders was made because in long cold spells the water, by forming into ice and by seepage, would likely be at a lower elevation than the curb. As cinders were plentiful and could be had for the hauling they were also placed as a backing against the curb.

The curb, as shown, served to retain the surrounding walks some 12 in. higher than the bottom of the pond. The curb was divided into 20-ft. lengths by expansion joints and laid in alternate blocks to facilitate their construction, and to provide for the placing of dowels.

*Superintendent, Fall River (Mass.) Park Department.

The forms were of the usual construction, except the form to hold up the face of the curb, which was No. 1 planed spruce, greased. They were erected in a continuous run, kept about a day ahead of the concrete and adjusted finally for line and grade just previous to placing the concrete. The expansion joints were formed by placing one thickness of three-ply tarred paper against the end of the finished section before constructing the adjoining length. To prevent the curb from being forced out of alignment two ¾-in. diameter wrought-iron dowels 18 in. long were placed at each joint half their length in each section. These dowels were wrapped in paper and carefully placed to prevent any bond between the dowel and the concrete. By this means contraction and expansion were provided for, but forces tending to throw the sections out of alignment were prevented.

The top of the curb and its face were troweled and finished similarly to ordinary granolithic work. The body of the concrete was a mixture of one part portland cement, three parts coarse sand and five parts crushed granite of No. 2 size (¾ to 1½ in.). The mix was placed rather wet in 6-in. layers, to save excessive tamping against the forms. The concrete was spaded against the back and toe of the curb to insure as smooth a surface as possible. The surface layer on the face of the curb was placed by plastering against the forms ahead of the concrete (keeping the plastering just above the concrete), insuring a complete bond, but giving a varying thickness of the surface layer from ¼ to 1 in. At no place was the body of the concrete allowed to approach the outer surface.

The concrete was left 1 in. low on the top of the curb and was immediately covered to the top of the form with a 1 : 2 surface layer in which the aggregate was coarse sand mixed half-and-half with fine crusher dust and colored with lampblack. The face form was carefully removed, and the face and top of the curb were floated and troweled to a hard smooth surface. The jointer was run at each expansion joint and in the middle of each section, giving the appearance of 10-ft. stones. A curved edger was run over the junction of the top and face of the curb.

Two ponds were thus encircled at a total cost of $1.69 per ft., there being 1,621 lin.ft. This cost includes every item connected with the work, which was done in 1906 and, except for the natural 10 years' wear, is in good condition.

Small Sewer Tunnel Makes Rapid Progress by Shield Work

In tunneling for a 48-in. concrete circular sewer in West Water St., northward from Florida St., Milwaukee, Wis., highly satisfactory results have been obtained on one section by using a shield. The soil is fairly stable and compressed air is not required; in fact an unbreasted face can be maintained most of the time. In spite of this condition the contractor's superintendent was convinced that he could do better with a shield than with square timbering as employed in other sections of the same work. The shield was built, and experience has justified its use. The rate of advance obtained is two or three times as great as with timbered excavation. The maximum has been 37 ft. in two 10-hr. shifts.

The shield is 7 ft. in diameter and about 9 ft. long. Its shell plate is stiffened by a circular girder inside in the usual way, and extends forward to a bracketed cutting edge of equal length all around (no hood). The tail is long enough to permit of laying up four or five rings of the wood segmental lining that is used to hold the excavation before concreting. There are seven jacks, but usually only a few of them are used. The heading foremen have acquired skill in selecting and controlling the jacks so as to guide the shield in alignment or grade as local conditions require. At the start of the work they were without shield experience and the path of the shield was rather sinuous, diverging by several inches to one side and to the other. After a few hundred feet, however, they became skilled enough to secure a very satisfactory straight path and could guide the shield at will.

The lining consists of 4x5-in. wooden cants or segments, with the 5-in. side radial. The tunnel wall is to be 9 in. thick (net), of unreinforced concrete. This thickness gives 4 in. leeway on either side, to allow for divergences of the timbered excavation from true line and grade. The concrete is, of course, carried tight up against the timbering.

The soil is a sandy clay occasionally somewhat fibrous, locally called marsh clay, overlying a peaty stratum over sand. The tunnel is 15 to 25 ft. below street surface. The section on which the shield is employed is being constructed by John F. Casey Co.

The 5-in. thickness of wood cant lining appears to be ample to resist the jack pressure required in forcing the shield forward. The lining compresses visibly for some 30 ft. back of the shield, and in some instances evidences of compression have been noticed as far as 100 ft. back. No ill results of this compression have been observed, however. Concrete will not be placed until the entire length of the shield section is completed.

The shield is advanced about 18 in. at each shove, the cutting edge being forced into the soil after the middle portion of the face has been excavated ahead. The shove brings down about half the amount of material displaced at each advance, and this requires only to be shoveled out. Subsequent excavation of the central part of the face is done by mattock.

The speed of advance of the method is essentially due to the assistance to excavation by the shove of the shield and eliminating the delay due to timbering, as the segments are easily and quickly placed.

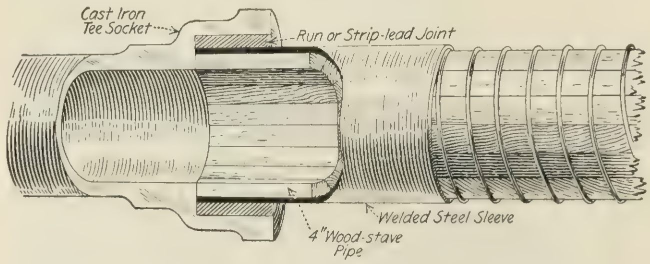
This sewer is part of the elaborate interceptor system now being built under the Milwaukee Sewerage Commission, T. Chalkley Hatton, Chief Engineer.

FINE AGGREGATE

Geographic Positions of Familiar Points may be obtained from bulletins published by the United States Geological Survey. These give latitudes and longitudes of marks at crossroads, township corners, etc., throughout given areas. One for the middle northwestern states has just been issued.

Accurate Triangulation for a Large Bridge—To locate the piers of the Metropolis Bridge over the Ohio River on the new Paducah & Illinois R.R. line of the Chicago, Burlington & Quincy Ry., very precise triangulation work was done. The low-water lines of the river are about 2,800 ft. apart, and the entire length of steelwork is 5,480 ft. A base 2,000 ft. long (approximately) was laid out on each bank, with one of its ends on the bridge axis. Measurement of these bases by refined tape methods determined their lengths with a probable error of 1:1½ million and 1:2 million respectively. Then the twelve angles of the quadrilateral were measured with a 10" transit having 8-in. circle. The greatest error of closure was 3". These errors were distributed, and the long sides of the quadrilateral computed. Taking the plan distances between piers and a fixed location for the first pier, the angles to the several pier centers were computed. To locate the piers the best angle from the ends of the base was chosen, and one transit set to this angle while another was lined to range in the bridge axis. No final check on span lengths will be obtained until the bridge superstructure is completed, as the only long tape available for measuring between piers was not standardized. However, the longest span of the bridge, the great 720-ft. channel span on the Kentucky side, joined up with all desired accuracy. W. McCready, Principal Assistant Engineer, carried out the survey work, under C. R. Fickes, Chief Engineer, Paducah & Illinois R.R.

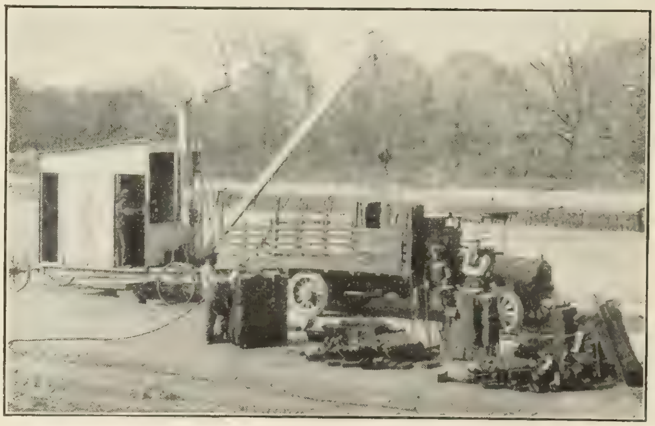
Joints Between Cast-Iron and Wood-Stave Pipes—Where special castings for hydrants, valves and other connections are inserted in wood-stave pipe, necessitating a lead joint between wood and iron, leakage is liable to occur owing to lack of adhesion between wood and lead. The difference in density of the two substances makes the proper calking of



METHOD OF FORMING JOINTS BETWEEN CAST IRON AND WOOD

the lead packing practically impossible. T. Pridham, in the "Commonwealth Engineer" (Australia), shows a method of remedying this defect by providing a joint that can be made fairly water-tight even under high pressure. The accompanying sketch is self-explanatory.

Unloading Paving Blocks with a portable derrick is shown in the accompanying illustration. The blocks are 2x5x12-in. asphalt, furnished and laid by the Asphalt Block Paving Co., Toledo, Ohio, for the paving of Shaker Boulevard between North Moreland and Coventry, suburbs of Cleveland, Ohio. The blocks were unloaded from the railway cars by placing



PORTABLE DERRICK UNLOADING PAVING BLOCKS

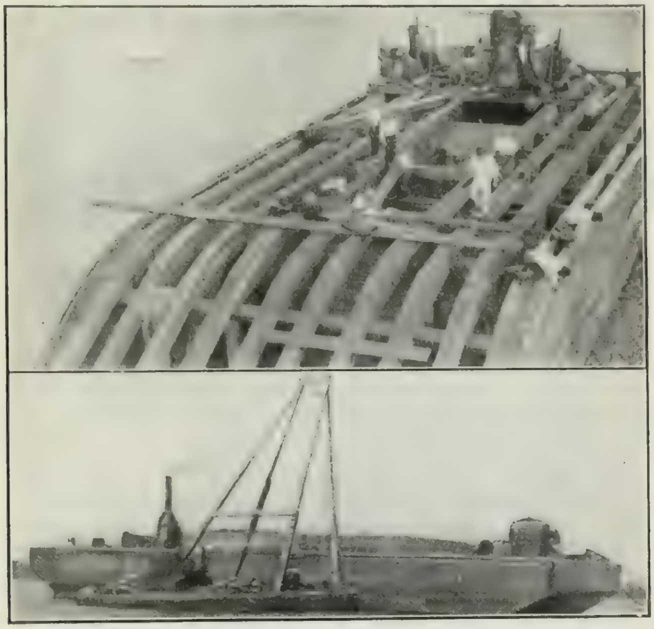
them in cages, like those shown, each cage holding about 100 blocks; these loaded cages were lifted from the cars and placed on motor trucks by a portable derrick. Another derrick of the same type was kept out on the road to unload the truck, as shown in the illustration. The cages were dumped and the blocks neatly piled by a crew of two, between trips of the truck. The derrick is moved from place to place by coupling it to the motor truck.

Mixed Wagons Can Be Started by a Steam Shovel, as is pointed out in Bulletin 18 of the Osgood Co. When wagons become mired in the loosely excavated material, so that it is difficult for the teams to start them, the dipper of the shovel can be placed at the rear end of the wagon and by means of a slow thrust from the crowding or boom engines, or by swinging the shovel, the wagon is forced to travel.

A Loose-Leaf Notebook of tracing cloth is urged by Roy C. Hardman, Box 455, Balboa Heights, C. Z. He says:

Sheets of this sort have a very decided advantage over paper sheets in that copies of notes may be readily obtained by blueprinting, and sketches may be traced from magazines and other outside sources. Matter may also be typewritten on the cloth sheets and clearly blueprinted if a black ribbon is used, and a black carbon copy be made of the reverse side of the cloth by the simple process of reversing the carbon sheet. As tracing cloth can be secured with different rulings, such as cross-section and profile, almost any sort of notes desired by an engineer can be made. An additional advantage is gained over paper inasmuch as the cloth is less liable to tear out at the binding rings of the loose-leaf binder. The cloth will also bear a great deal more wear than paper.

Salvaging a Hopper Scow in the Hawaiian Islands is shown in the upper view. The scow belongs to the Hawaiian Dredging Co., is 94x36 ft. in plan by 13 ft. deep and draws 4 ft. light and 10 ft. loaded, the loading capacity being 300 cu.yd. Some time ago the scow broke loose in a storm and drifted on the rocks. An anchor scow, brought alongside during the work of examination to determine the possibilities of rebuilding added to the damage by colliding with the al-



SCOW BOTTOM UP WITH REPAIRS MADE: RIGHT SIDE UP AND O. K.

ready wrecked scow. The scow had cost $15,000 to build, and it was estimated that the repair charge would amount to $3,000. The actual repair cost reached $6,000. To repair the bottom, the scow was rolled over in the water, it being shown upside-down in the upper view. The lower view shows the hull rightside up again, after repairs had been completed.

Pipes First Are Struts, Then Drains—Rudolph N. Maxwell, 3541 Trimble Ave., Cincinnati, calls attention to a retaining wall of the Pennsylvania R.R. at Torrence Road station, near Cincinnati, in the recent building of which lengths of cast-iron pipe were used first as bracing for the foundation trench and ultimately as weep holes. The excavation, which was some 15 ft. deep, had been very heavily timbered to prevent the hill above from sliding. The crossbraces or struts that ran from front to back, holding the horizontal rangers in position, consisted mainly of 8x8s, but these were placed so closely together that it would have been unwise to leave them in the concrete. Not only would they have considerably reduced the concrete volume of the wall, but they would also have endangered it, owing to the swelling of the wood during concreting. To overcome the difficulty, heavy 2-in. cast-iron pipe was substituted for the wood crossbraces before concreting. The pipe was cut to the proper lengths, and as one pipe was fitted alongside a corresponding wooden brace, the brace was removed. This was continued until all the struts had been taken out and only the pipe remained.

Moving a Town of 51 houses would seem to be a job of some magnitude, but a contract for this very work has been let by the Town of Barfield, Ark., to J. N. Thompson, of New Madrid, according to press dispatches. Barfield is located on the Mississippi River, and caving banks have necessitated the construction of a loop in the levee at this point. The houses are to be moved back out of the loop, and the cost of the moving is estimated at $10,000.

Hillside Asphalt-Block Pavement is now being laid in the same manner that wood-block pavement has been constructed under similar conditions. Between each row of blocks a narrow strip of wood or lath is placed so as to separate the

ASPHALT-BLOCK PAVING ON GRADES

rows by ⅜ to ½ in. The view shows a pavement being put down in this manner on the Albany Post Road in the village of Dobbs Ferry, N. Y. A total of 40,000 sq.yd. was laid on this contract by the Hastings Pavement Co., New York City.

In Patching a Brick Pavement on the Warrensville road, near Cleveland, Ohio, a small Schramm portable air compressor and a pneumatic tool were found useful and economical. The pavement was comparatively new and was damaged, it is claimed, by a heavy motor truck before the foundation concrete had properly set. The edges of the patch were first cut with the pneumatic tool, the ends of the brick be-

AIR TOOL USED FOR MAKING PATCHES IN A BRICK PAVEMENT

ing carefully cleaned of all old mortar. The main part of the patch was then broken up and removed with a sledge hammer and pick. The air tool was also used to clean the brick, which were to be relaid. The two men shown in the accompanying view comprised the whole repair gang.

Contracting in the "Dry" States will not appeal to many hearties. The paving specifications of Arkansas City, Kan., (and of other Kansas municipalities, too) contain this provision: "Alcoholic Liquors—All work under this contract shall be executed without the excessive use of alcoholic liquors by the contractor or his foreman. The use of the same shall be considered sufficient cause for declaring the forfeiture of this contract." What constitutes "excessive" use of inebriating fluids evidently depends on the convictions of the engineer. Experience sometimes leads to the belief that alcohol is to a construction foreman what gasoline is to the automobile.

Editorials

Concerning the Miami Flood Studies

The Miami River flood-protection project is so novel—we might indeed say so unprecedented—that there is the more satisfaction in knowing of the elaborate engineering investigations on which it was based. No other construction project in recent years has had as thorough preliminary work done on it.

The engineers faced new problems. They felt it due the problem, due themselves and the people of the valley, that every step in the planning should be questioned and investigated until all chance of doubt was removed. Money enough was available to pay for this investigating, fortunately.

Controlling the floods of a 2,500-mi. area has not been accomplished before; certainly not in America, and nowhere for so flashy a stream as the Miami. It was clear that new means and methods would have to be devised. The starting difficulty, however, was that the data for the problem were lacking.

To begin with, it was necessary to find how great a flood may come to pass in the Miami Valley. Prior storm and run-off studies have dealt with short rainfalls, something radically distinct from the great storms—great in area, duration and intensity—that were in question here. Therefore a new line of study had to be undertaken, flood-storm research and analysis of future storm probabilities. The forecasting, of course, had to be done in the light of what has happened in the past in all parts of the country having similar conditions of climate. To be safe in the forecast it was necessary to search the entire world's records for all pertinent data.

The nature of the flood research, and the reasoning based on it, are sketched in this issue. In subsequent issues of *Engineering News* further problems of the Miami work will be discussed.

The District is planning to publish ultimately its most important engineering studies in the form of separate monographs or reports. Needless to say, these monographs will be valued contributions to the permanent records of civil engineering. They will also furnish the material for a fuller and better understanding of the Miami Conservancy work than can be obtained otherwise. In the meantime, however, the brief sketches of the work given by our present articles afford a more general perspective of the work than has yet been made available to the engineering reader.

It is a fact that outside of the group of men who coöperated in the work of the Conservancy District few engineers have grounds to be otherwise than skeptical and doubtful about the soundness of the project. They know that the scheme contains new elements, but they have not been told why these are necessary, why simpler and better-known expedients would not suffice, or how the Miami engineers have assured themselves that the new expedients will work. Our series of articles will supply answers to these questions. It should suffice to remove the doubts and skepticism. The enterprise deserves to be understood and be believed in by the entire engineering profession.

The work is a monument to the men engaged in it. The main credit belongs to its leader, Arthur E. Morgan, Chief Engineer. But the men in the organization which he brought together contributed knowledge, ability and faithfulness in remarkable degree, and their part in the results is equally worth remembering.

Work for the Successor of the Joint Committee on Concrete

The final report of the Joint Committee on Concrete and Reinforced Concrete, noted in this issue, is an important and praiseworthy document. In a way it marks the end of a structural era for by it the period of doubt regarding the design of reinforced concrete is definitely brought to a close. Through the medium of a score of well qualified experts the developed knowledge of a decade of reinforced-concrete designing has been crystallized so that in fact, if not always in form, it can be used as a standard for some years to come. In the main, the criticisms of the past four years have proved most salutary and the objections to the earlier reports have been considered and satisfied by correction and addition.

It is too much to expect that there will be no opposition to some of the details of design, or that the objectors will invariably be wrong. Universal acceptance of any theory is practically impossible and when theory encroaches so far on the realm of empiricism as does the chapter on the flat-slab floor in this final report, it would be indeed strange if other theories equally defendable did not find their propounders. Such criticisms and objections will undoubtedly come, but as an ultimatum on design the report comes well within the limits of error permitted all joint efforts of this sort.

Design, however, is only a part of the problem of structures, a most important part, to be sure, and one in which it is easy to be didactic. In concrete it happens to be the part which though the subject of more-or-less argument has been the source of the least trouble in practice. One has only to read the stories of concrete failures—complete or partial, sudden or continuous—to realize that the essence of concrete construction is the manufacture of the material and that its future stands or falls upon a better knowledge of that material. And for this phase of concrete the final report of the Joint Committee has little more than the insubstantial generalities of its two predecessors.

Eight years ago these generalities were acceptable. Reinforced concrete was sufficiently novel to make its design of paramount importance and incorrigible optimists were sufficiently in evidence to discourage any serious doubt as to stock methods of construction or to the evil effect of such methods on the permanence of the structure.

Of late, however, whispered doubts have become vociferous. Examinations of concretes of a decade ago have aroused professional fears, questions of aggregate composition and grading absorb laboratory specialists, and the apparently simple matter of consistency has veered from a minimum to a maximum of water and is now swinging back toward the very dry mix of the earlier days. Such doubts and questions, which are the very life of the concrete industry today, could never be learned from the final report of the Joint Committee, unless they could be inferred from the blanket prefatory phrase stating that "there are some subjects upon which experimentation is still in progress."

One cannot justly criticize the committee for not solving these problems. The state of the art probably does not yet permit their solution. It must be criticized for avoiding them, for not, in a footnote at least, making some reference to the doubts that assail the honest concrete expert today in the manufacture of his material, for not referring to such matters as the schism among experts as to the importance of aggregate gradation, the unexplained continuous deflection or shrinkage observed by various experimenters, or to our ignorance of just how much water we should mix for optimum effect.

That such questions remain unanswered by the final report emphasizes the committee's expressed hope that some other equally qualified body will take up the future authoritative study of concrete and that it should not be supposed that all that can be known is now before us. The Joint Committee's arduous work is now done—on its own statement—and well done, but its spiritual successor will have plenty to do.

Making Filter Alum While You Wait

When some Oriental first put a lump of alum in the family water jar to hasten sedimentation he never dreamed of the part that alum or sulphate of alumina would play in the purification of public water-supplies centuries later. Today millions of people throughout the whole world are dependent on the use of this coagulant for clear, sparkling, safe water at a slight increase over the cost of muddy, or color-stained water, perchance teeming with disease germs.

The widespread use of alum in water treatment is due to American brains, energy and money. Beginning and continuing with the remarkable growth of the use of mechanical filters, the use of alum as a coagulant has since been extended in its original domain, or as an aid to clarification by sedimentation—without filters, and also with slow sand filters as well as with mechanical filters. Alum also pays a notable part in the removal of color and even of tastes and odors.

Until quite recently water-purification works depended on the open market for their alum. A few years ago one or two enterprising British cities began to make their own alum—a fact little known in this country. The idea was either taken up or else separately conceived by one of the most progressive water-purification chemists in this country, Mr. Hoover, of Columbus, Ohio, who first worked out a scheme for making syrup of alum at the Columbus water purification and softening works and then turned his attention to the production of crystallized alum. Mr. Hoover's success has been such that his process, now patented, has been put in use at three other water-filter plants in the United States, and one in Canada. It seems destined, like mechanical filtration, to extend throughout the world.

The Hoover process of making alum and its manifold notable advantages are briefly stated elsewhere in this issue in the introduction to descriptions of alum-making plants at Columbus, Ohio, Trenton, N. J., and Springfield, Mass. The plant at Omaha, Neb., will be taken up in a later issue. The several descriptions have been prepared by the chemists or engineers in charge of the several works.

Alum is made regularly at the several works, by means of simple and low-cost installations. It is made up daily—"as you wait," almost—by the ordinary force and under the direction of the chemist or other head of the purification works. The resulting product is not only much cheaper than commercial alum but is also far better suited to use as a coagulant—one reason why it is cheaper.

Particular attention may well be called to the fact that simple as are the process and installation, the descriptions of the four plants show an interesting variety of detail in both design and operation that will repay the study of those interested in the process and also of those who wish to note the many ways there are of solving very much the same engineering problem, so as best to make the solution fit local conditions or personal preference.

Opposition To Postage Zone System

The proposal to increase from two to six times the postage on publications sent over 300 miles, which was reported as a rider on the Post Office Appropriation Bill by the House Committee on Postal Matters has met with strong opposition. The plan of those promoting the bill was to have the House Committee on Rules take action approving the measure as germane to the appropriation bill so that it could be carried through the House as a "rider" with little opportunity for debate. Chairman Henry of the Rules Committee, however, is reported in Washington dispatches as declaring that a strong case against the bill has been made out and that his committee favors full consideration of the bill before passage.

Postmaster-General Burleson has urged on the Post Office committee that in view of the abnormal increase in the price of paper, "most serious consideration should be given to the representations of the publishers and it might be well to consider whether the increase in rates of postage on second-class matter should be made at this time."

A committee representing the editors of technical journals has formulated a protest to members of Congress, a part of which follows:

> The chief ground of our opposition is that the effect of this measure would be to destroy one of the strongest forces that has operated to produce national unity. The circulation of national journals has tended to develop common thoughts and ideals in all parts of the United States, and to break down sectional barriers.
>
> Under the zone system the postage on all publications sent more than 600 miles would be three to six times the present rate. The inevitable effect would be the practical suppression of journals of national circulation.
>
> We protest against the enactment of the rider, in addition, on the following grounds:
>
> 1. It would discriminate against the farmer, the lumberman, the miner, the merchant, the manufacturer, the physician, the engineer in the remote sections of the country, by charging a high postal rate on information essential to their calling.

2. It would place a crippling tax on the periodical press, which, next to the schools themselves, is the greatest educational power in the country.

3. It would seriously retard our development in agriculture, in trade, in manufacturing, in medicine, science and engineering by restricting the spread of information essential to development in these lines.

4. It would place a drastic tax on the now widely circulated journals of the great scientific and engineering societies, whose members, impelled by patriotic motive and without pay, rendered yeoman service on the Industrial Preparedness Committee of the Naval Consulting Board and which now are giving freely of their time, in answer to the call of the President of the United States, in the work of the National Research Council.

5. It is based on the erroneous assumption that postal expenses increase in proportion to distance. This has been known to be false since at least 1837, when Sir Rowland Hill showed that, even with the crude transportation of those days, terminal expense was 90% of the whole cost of mail service.

6. It would fail to accomplish the object intended, which is to increase postal revenues. The increased cost of subscriptions at long distances would result in a general cancellation of such subscriptions, and consequent loss of the expected postal revenue.

It is to be hoped that the protest made by those connected with the publications affected may be supplemented by many protests from individuals to the Congressmen from their own districts. The Government this year appropriates some $60,000,000 to carry on the rural free delivery service, not because it returns a revenue at all proportionate to its cost, but because the Government desires to bring the benefits of convenient postal service to those who dwell on remote farms. On the same principle, the Government in any revision of the postal rates ought not to take away from the man in remote parts of the country the privilege he now enjoys of receiving the best publications at no higher cost than the dweller in or near the great cities.

A Last Word on Valuation Principles

The Special Committee of the American Society of Civil Engineers on Valuation for Rate Making has presented a final and unanimous report. It is remarkable that seven eminent engineers of such diverse interest and experience as Messrs. Stearns, Metcalf, Churchill, Riggs, Raymond, Snow and Wilgus, should be able to agree so completely on such a comprehensive array of principles and procedure in what has been heretofore such a highly controversial subject not yet emerged from a formative stage. The unanimity of the committee members is especially remarkable in that the report pursues almost to a finality the subject of depreciation, a topic on which committees break up and individuals wax angry. The subject of valuation hereafter ought to be less controversial because of this pronouncement. Until the courts of the land authoritatively settle some pending valuation questions (like the preference for original or present physical conditions, or the treatment of land holdings) and that will be many years, this report must be accepted as a last word.

The report will always stand conspicuous among the reports of the American Society, and indeed among all societies; it probably holds the record for amount of effort involved. All through it are the evidences of the Committee's study, labor, knowledge, wisdom and diplomacy. Yet it is not a report that can be absorbed in one reading, even by those working in this field; it is a document, appreciation of which will come slowly to most readers and the committee has done well to recommend that it be not discussed until the summer convention of the society.

The report is very extended. At some points of its 210 pages it goes to the verge of diluteness, though experience teaches that this will not be an unblessed trouble. Some sections will be more readily grasped than others but eventually the committee's candor and judicial attitude throughout will be recognized; after a few paragraphs have been rephrased, its views, undoubtedly, will be largely accepted. The report will be found pretty generally progressive—it reads the handwriting on the wall even though it has a proper and comforting regard for the equities of property rights developed under a *laissez faire* attitude.

The report in the first place clearly differentiates between valuation for rate-making, purchase, capitalization and taxation. The next effort is to distinguish, for illustrative purposes, between the combinations of principles which should be applied to new properties, old properties under continuous regulation and old properties not under continuous regulation. The report outlines what property is to be covered in an appraisal, and how original-cost-to-date and cost-of-reproduction figures are to be arrived at, leaving it to court or commission to decide which shall have more weight in the ultimate "fair value."

Another point in which the report is diplomatic is the question of whether original or present physical conditions should control in estimating reproduction cost. The committee recommends the assumptions that the identical property is to be reproduced, that present-day conditions affecting cost be considered, and that history be consulted for what is to be considered reproduced and the conditions governing the reproduction estimates. For doubtful or attacked items, it is recommended that the engineer clearly present the results of both theories.

As to the reproduction cost of land, the committee argues for recognition of historical conditions in fixing cost of severance damages, and for transfer of relations between actual acquisition costs of parcels and old normal market value of original tracts to present-day market values of contiguous tracts in valuing carved-out parcels. But the committee displays a caution signal—warning that the engineer should confer with counsel upon the hypothesis most applicable to the case in hand.

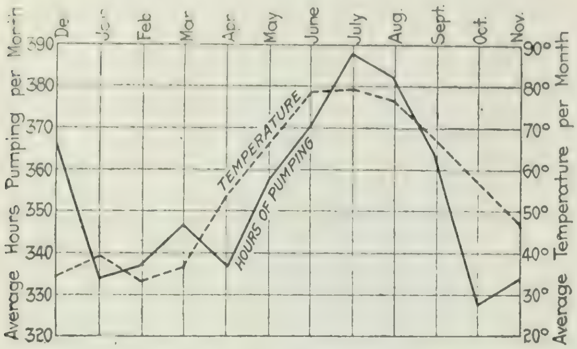
The committee's most skillful work lies in the chapter on depreciation, where it has done the impossible feat of harmonizing the old railroad claim that there was no depreciation of a well-maintained railway in spite of the depreciation of its elements and the reformers' claim that utility rates are to be based on diminished values.

This happy result has been secured by reviving the old word "decretion" and giving it the special meaning of "loss of service life." This it explains is the cause of any depreciation of valuation that can be admitted. Where the public has fully repaid the investor for the cost of this decretion, together with all operating expenses, and a fair return always, the cost of decretion has been converted into depreciation of value, or "fair depreciation" to use the committee's term. Otherwise, in rate-making bases, decretion-cost has been and will be converted to fair depreciation, irrespective of the actual decretion, only to the extent to which the customers have repaid the cost or by which the utility has sacrificed return through laxity, error or shortsightedness. Uncompensated decretion-cost is an obligation of the body of customers—an asset of the utility preserving its equity.

Letters to the Editor

Temperature and Water Consumption

Sir—The accompanying curves show a notable similarity between the number of hours of pumping per month and the average temperature per month for a suburban water plant in Maryland. The plant has five deep-well pumps, $7\frac{1}{2}$ mi. of



TEMPERATURE AND WATER CONSUMPTION

4- and 6-in. main, and supplies a high-grade suburban development. All services are metered, and there is very little leakage from the mains. As information relative to comparatively small water-works is difficult to obtain, it may be that your readers would find this chart interesting.

BANCROFT HILL.

Keyser Building, Baltimore, Md., Dec. 16, 1916.

Baker's Report on Chicago Pavements

Sir—In your issue of Dec. 7 you call attention to the report of Prof. I. O. Baker on his investigation of the paving operations of the City of Chicago, and in particular you quote the amounts of money that he estimates have been lost to the property owners of the city because of defective work.

It may interest your readers to learn of the methods by which he makes these computations. On page 12 of his report he refers to measurements of the thickness of concrete base in three streets and says:

> The shortage in each of the three cases respectively is: 21, 12 and 21%, or an average of 18%, regardless of the relative areas or of the relative number of observations. The above are all the definite data I have or can find on the thickness of the concrete base. If it be assumed that these data are representative, the possible loss to the property holders by skimping may be computed as follows: In 1915 the board laid 1,498,000 sq.yd. of pavements having a concrete base. The materials of the base cost about 60c. per sq.yd. Hence the loss was 0.18 × 1,498,000 × 60c. = $161,184.

On page 26 he calls attention to the thickness of the asphalt binder on three streets and says:

> In the last three cases the shortage is respectively 23, 27 and 23%, and the average is 24%. I see no reason why we may not assume these examples to be representative. Therefore, since the binder course costs about 46c. per sq.yd. in the wagons on the street, the average saving, as above, is 24% of 46c., or 11c. per sq.yd.; and since about 843,000 sq.yd. of asphalt pavement were laid in 1915, the total loss to the property holders through skimping the binder course was 843,000 × 11c. = $92,730.

He apparently forgets what he has said on page 25:

> Actual vs. Theoretical Thickness. Table 2, p. 25, shows a comparison between the theoretical area and the actual area covered by the asphaltic binder sent to three streets in 1915. These data were furnished by the Staff. Notice that the deficiency in thickness varies from 5.3 to 12.3%. In the case of Kildare Ave. the shortage in thickness is equal to $\frac{3}{16}$ in. over the entire street, which means that the city got a binder course $1\frac{5}{16}$ in. thick instead of one $1\frac{1}{2}$ in. thick, as required by the specifications.

On page 29 he calls attention to the thickness of the asphalt wearing coat on four streets and says:

> The shortage in the several cases above is respectively $12\frac{1}{2}$, $12\frac{1}{2}$, 20 and 14%; and the average of all, regardless of the relative area, is 15. I see no reason why we may not assume these examples to be representative. Therefore, since the cost of the 2 in. wearing coat in wagons on the street is about 66c per sq.yd., and since about 648,000 sq.yd. of 2-in asphalt pavements were laid in 1915, the total loss to the property holders by the above skimping was: 648,000 × 0.15 × 66c = $64,152. By a similar computation the loss on $1\frac{1}{2}$ in. asphalt wearing surface was about $14,625. Therefore, the total loss was $78,777.

On page 1 he says:

> This report is based upon the following information: (1) Three days spent with an automobile inspecting pavements and asphalt plants; (2) a study of the current specifications of the Board of Local Improvements; (3) a discussion for half a day with the Chief Engineer of Streets from previously prepared memoranda, and correspondence with him since; (4) an analysis made at my request by the Staff of the Finance Committee of the paving specifications of Chicago and of such other paving specifications as were on file in the office of the Staff; and (5) inspection of field books and reports on the data therein by members of the Staff of the Finance Committee.

During the past season the Board of Local Improvements has paved approximately 200 mi. of streets, and the year before we paved less than 150 mi. of streets. It was necessary to increase our inspection force, and skilled competent inspectors were not to be had. It was to be expected that with inexperienced, incompetent inspectors some faulty work would be done. It is, however, not to be expected that a man in Professor Baker's professional position should base conclusions covering 300 contracts from observations made on three or four contracts.

It is of no more importance that an engineer be accurate and honest in making an estimate upon which to base the payment of money than it is to be accurate and honest in making an estimate upon which to base an attack upon another engineer's work.

It is this unfounded estimate of the money lost by the property owners that was seized upon by the daily press as something sensational, with the result that the public was filled with the belief that the Board of Local Improvements and its engineers were corrupt and were robbing the property owners. Even "Engineering News" follows the example in publishing that part of the report which is most unfair, unfounded and defamatory.

There are many things pointed out in this report which call for change and correction, but the character of the report is such as to discourage any reform. Nowhere in the report of 46 pages is there any recognition of merit either in the specifications or in the method of doing work, nor is there any recognition of the difficulties under which the engineering force operates. Everywhere there is fault finding—some of it just, much of it petty, hypercritical or unfounded.

C. D. HILL,
Engineer, Board of Local Improvements.

Chicago, Ill., Dec. 15, 1916.

[In accordance with our usual custom, proof of the above letter was submitted to Professor Baker, who replied as follows.—Editor.]

Sir—The matters discussed by Mr. Hill comprise only a small part of my report, although they are the parts that received publicity in the newspapers. The notices in the newspapers in no way or degree came from me [They are, however, bona fide extracts from Professor Baker's report.—Editor.] and misrepresent the spirit of my report, and say nothing of its constructive features. I do not understand to what these notices refer when they claim that I allege a loss of something like $50,000 (I write from memory) through skimping in the use of cement.

IRA O. BAKER.

Urbana, Ill., Dec. 22, 1916.

Badges for Junior Members of the American Society of Civil Engineers are the subject of an inquiry from a subscriber who writes:

> Junior members of the American Society of Mechanical Engineers are entitled to wear a society pin similar, except for color, to that worn by the members. Why has the American Society of Civil Engineers never allowed its Juniors the same privilege?

Possibly the reason may be because there are already two kinds of badge worn by those associated with the American Society of Civil Engineers, one a blue enamel worn by Members and Associate Members, and the other a maroon worn by Fellows and Associates. It may have been thought unwise to authorize a third kind of badge.

Court Denies Right To Enlarge Columbus Flood District

The official court hearing on the Scioto River flood-protection plan, drawn up by Alvord & Burdick, Chief Engineers to the Franklin County Conservancy District, in Ohio, began Dec. 6. The hearing covered the two separate questions of approval and adoption of the plan, and enlargement of the district in order to spread the assessment of cost over the whole area benefited by the work. The district as organized is coextensive with Franklin County, in which lies Columbus. The engineering investigation, however, showed that combined retarding-basin and channel-improvement control is best, and this led to application for enlargement of the district. At once the objectors outside of Franklin County raised the legal question as to the right of the district, as at present constituted, to enlarge by taking in the additional territory to protect Delaware, Chillicothe and the farm lands between these cities on the bottoms of the Olentangy and Scioto Rivers.

The argument occupied an entire day. On Dec. 12 the court announced its ruling that the district as at present constituted could not enlarge by taking in territory outside of Franklin County, upon the ground that to take in territory in other counties at a hearing before the judges of Franklin County only would be an unconstitutional proceeding.

This decision nullifies part of the Vonderheide conservancy law. The proper boundary for a large flood protection district such as a watershed of a river or the greater part of an extensive river valley can only be determined after more or less expensive engineering study and investigation. The law provides that a district may be formed upon tentative boundaries by showing in court that protection is needed and can be secured. It provides that the county is the original unit over which a three-tenths mill tax can be spread for the purpose of a preliminary investigation. The law assumes that the funds thus raised will be sufficient to determine more definite boundaries for a proper district in which benefits will exceed costs. After the proposed district has been formed, the official plan approved, and the necessary taxes have been levied upon the district, the money originally advanced by the county is refunded.

The law provides as to how the district shall be extended, namely, by hearings in a court consisting of judges of all the courts of common pleas. The law does not require, however, that the judges of any courts outside of the courts in the originally constituted district shall sit in the proceedings relative to the enlargement or contraction of the district.

A similar question did not arise in the Miami District. There the preliminary expenses were all paid by private subscription, before the original application for forming the district was made. When formed, the district was substantially the same as that affected by benefits and damages of the revised plan finally developed.

The court confined further testimony to costs and benefits to be derived in protecting Franklin County alone, assuming that the works proposed were adequate for the purpose claimed. Hearing upon this question was resumed Dec. 18 and the testimony was completed Dec. 21. No decision has been rendered as yet. If the decision is favorable to the district, it is presumed that the hearing will proceed on the question of the adequacy of the proposed flood protection measures.

Testimony was presented by the district indicating that the official plan as proposed for Columbus and all the territory between Delaware and Chillicothe is the most effective and economical plan even if the entire cost should be spread upon Columbus and Franklin County alone; that the works to be constructed for $9,505,112 include about $2,500,000 for land in the detention basins which would practically be as good for farming as before the construction of the detention dams; that the revenues from this land would be about $120,000 per year; that a water supply for Columbus could be secured up to the year 1950 by the storage of water in the lower ten per cent. of the detention basin outside of the great flood season, thus performing a service to Columbus whose present worth is estimated at $1,000,000. It is expected that the city would finance and acquire by rental this storage right. If so, the cost of the flood-protection would be reduced to about $8,500,000 for assessment against benefited property.

It was shown that the 1913 flood losses in Columbus and Franklin County amounted to $6,176,800 direct loss and about $10,000,000 indirect loss. It was shown by testimony that the real property, including real estate privately held and the real estate of the railroads and public service corporations, amounted to $41,500,000. This is the value as it existed immediately prior to the flood and which it was shown, although materially depreciated, would be automatically fully restored with the assurance of protection. Dividing $8,500,000 into 30 annual instalments as provided by law and deducting the revenue from farm lands in the basins ($100,000 per yr.) the assessment against the benefited real property in Columbus would be about $4.40 per annum per $1,000 of value. This would be about as much as an ordinary paving assessment against a lot. If interest is included (the law specifically excludes it), the assessment would be $7.60 per $1,000.

The objectors presented testimony to show that the value of the real property as shown upon the 1910 tax duplicate in Columbus and Franklin County within the flood zone was about $24,000,000. Upon cross-examination it was shown that this did not include the municipal improvements in the streets nor the real property of the railroads and public service corporations incident to operation, which is carried on the books of the State Tax Commission. These allowances with a further allowance of 25% to represent the difference between the true value of the real property privately held and its value upon the tax duplicate would make the figures on value presented by the district and the objectors substantially agree.

The district presented six prominent real estate dealers who testified that property in the flood zone had been reduced about 50% in value since the 1913 flood, that it would automatically be restored at once with the assurance of adequate protection and within a short time it would be restored to values materially greater than those prevailing before the 1913 flood.

The objectors presented an equal number of real estate men and residents of the flood zone. These witnesses generally agreed that adequate protection would restore values at least to the values prevailing before the flood, but questioned whether the construction of dams would not create a fear preventing restoration of the values.

Average Earnings of Civil Engineers

SYNOPSIS—Abstract of the final report of the Special Committee to Investigate the Conditions of Employment and the Compensation of Civil Engineers of the American Society of Civil Engineers.

The most complete investigation ever made to determine what are the average earnings of men engaged in civil engineering has been completed by a committee of the American Society of Civil Engineers. The report of the committee appears in the December "Proceedings" of the society, and will be presented for discussion at the coming annual business meeting. Two years ago the committee presented a progress report, based on returns showing the earnings of two-thirds of the membership of the American Society of Civil Engineers (*Engineering News*, Jan. 7, 1915). The present and final report includes in addition the information collected from 263 additional members of the society who have joined it during the last two years, and 1,319 reports from engineers who are members of local engineering societies but not members of the American Society of Civil Engineers.

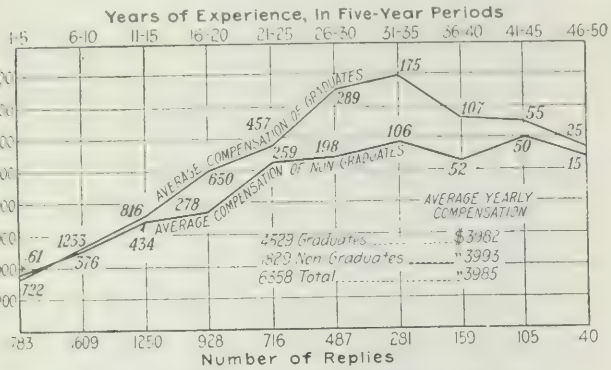


FIG. 1. COMPARISON OF GRADUATE WITH NONGRADUATE ENGINEERS

The final statistics now presented, therefore, show the earnings of 6,378 different engineers, representing a total annual income of $25,420,000.

As this journal has pointed out in connection with previous reports of this committee, it must be remembered in studying its diagrams that the figures represent not the earnings of the average men in the profession but of the selected men who reach a position of sufficient prominence to gain admission to an engineering society and to afford its annual dues. Of course, there are a great many civil engineers of high reputation and large professional earnings who are not members of the American Society of Civil Engineers. It will generally be agreed, however, that the average earnings of the 40,000 to 50,000 civil engineers in the United States are very much lower than the earnings of the reporting members of the American Society of Civil Engineers or of the nonmembers from whom the committee received reports.

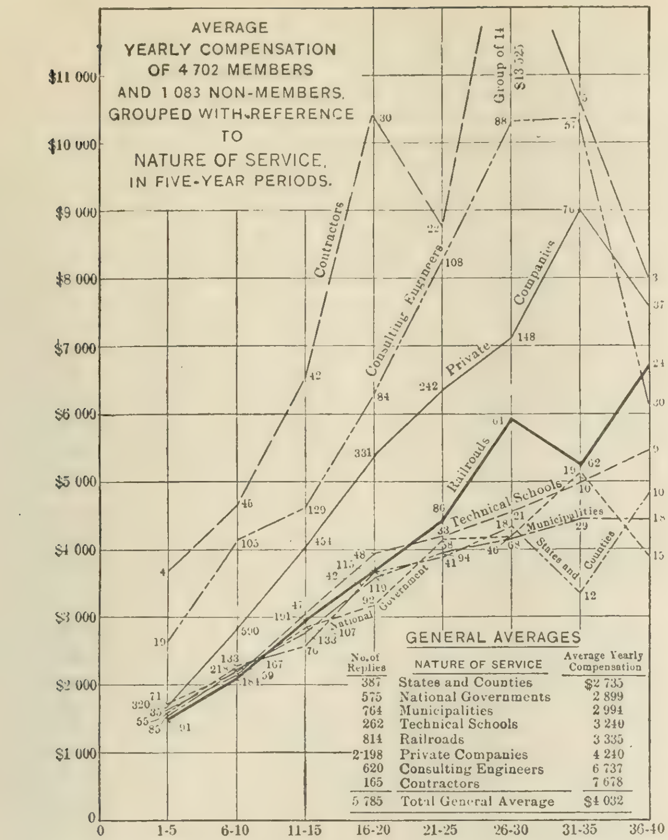
In studying all the diagrams, it should be kept in mind that the erratic variations on the curves do not represent any general law but merely exceptional variations in the earnings of a few individuals. According to the figures on the diagram, for example, the average yearly earnings of civil engineers of twenty-nine years' experience is $8,690, while the engineers of thirty years' experience earn only $5,131, and the engineers of thirty-one years' experience $8,810. There is of course no reason why the average engineer of 30 years' experience should earn any less than at 29 years. The sudden drop in the curve at 30 years' means nothing more than the men who had just thirty years' experience happened to include an unusual number with very low earnings and few men with very large earnings.

Two diagrams of great interest to the young engineer are those which present the average earnings in various classes of engineering service and in various parts of the country. The very meager salaries paid to engineers in all government work, municipal, state, or Federal, are pretty well known in the profession, and are well shown in the record of average yearly compensation given on one of the diagrams. If these low salaries for public work were compensated for by permanent positions, and by pensions in case of disability or at the attainment of a retirement age, there might be some excuse for these low salaries. Under present conditions, however, the ambitious and competent engineer shuns a position in public service with its uncertain tenure if he can find any promising opportunity elsewhere.

Compared with the salaries paid by cities, states, and the nation, the technical schools show up very well, particularly considering the favorable conditions of service. The railway companies have never paid for civil engineering service what it should be fairly worth, one reason for this doubtless being the very large number of applicants for positions with the railway companies from engineers who have been employed on construction work. The average earnings of the engineers listed as contractors, far exceeds the earnings reported in any other field of work. It must be remembered, however, that the contractor's earnings are always accompanied by a considerable element of risk. In order that the earnings in contracting should be directly comparable with the salaries paid by railway companies or to engineers teaching in the technical schools or to those on government work, a certain deduction should be made for the risk involved in the contracting game.

The diagram showing the variation of civil engineering earnings in different parts of the country puts into definite figures what has heretofore been generally known by those of wide experience in the profession. The best prizes in the profession go to those who achieve sufficient distinction to be sent by American capitalists to foreign countries. New England and the Southern States have the unenviable distinction of paying lower compensation to engineers than any other part of the country, with the exception that a few New England engineers of advanced years and national reputation have very high incomes which serve to bring up the average of those having 30 to 40 years of experience.

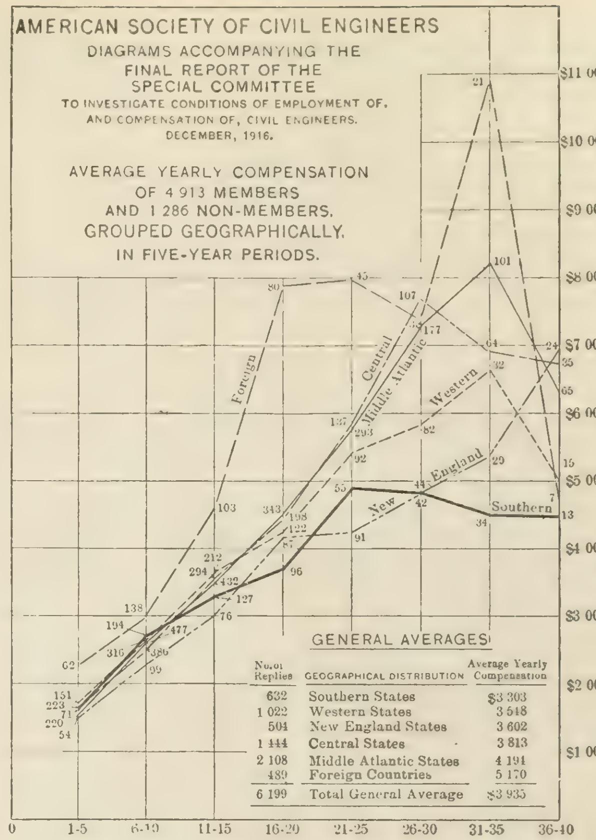
A good deal has been published contrasting unfavorably the compensation of engineers and that of other professions, such as lawyers or physicians. Doubtless some of these comparisons are at fault in that the comparison is made between an engineer of average attainments and compensation and a physician who has acquired a large reputation and lucrative practice. The committee in its



GENERAL AVERAGES

No. of Replies	NATURE OF SERVICE	Average Yearly Compensation
387	States and Counties	$2 735
575	National Governments	2 899
764	Municipalities	2 994
262	Technical Schools	3 240
814	Railroads	3 335
2 198	Private Companies	4 240
620	Consulting Engineers	6 737
165	Contractors	7 678
5 785	Total General Average	$4 032

FIG. 2. DIAGRAM BASED ON NATURE OF SERVICE



GENERAL AVERAGES

No. of Replies	GEOGRAPHICAL DISTRIBUTION	Average Yearly Compensation
632	Southern States	$3 303
1 022	Western States	3 518
504	New England States	3 602
1 444	Central States	3 813
2 108	Middle Atlantic States	4 191
489	Foreign Countries	5 170
6 199	Total General Average	$3 935

FIG. 3. DIAGRAM BASED ON GEOGRAPHICAL GROUPS

FIG. 4. GENERAL CURVES GIVE INCOME STATISTICS OF 6378 ENGINEERS BY YEARS OF SERVICE

report states that it has attempted to secure information as to the average compensation of members of other professions than engineering, but has not found any definite information. The committee voices its opinion from such meager information as it has been able to obtain that the compensation for engineering work compares favorably with that received by men of any other profession.

When the committee was originally appointed there was an idea that it might make some investigation to determine the causes why a considerable proportion of the engineering profession is underpaid in proportion to its responsibilities and to the expense of professional education. The committee, however, has confined its work chiefly to the collection of the statistics which it presents. The following paragraphs from its report, however, are of some interest in this connection.

The underpaid engineer does not always owe his failure to receive a salary commensurate with the importance or difficulty of his work to the ignorance or lack of appreciation of laymen, but it not infrequently is the fault of his engineering superior in the organization of which he is a part. The replies received by the committee indicate that engineers in private practice sometimes employ men of extensive experience, and presumably of good ability, at salaries which young graduates with little or no experience are able to command, but which are less than those of an ordinary mechanic who has a labor organization behind him.

It may be urged that the competition for work on the part of engineers who employ a technical staff is so keen that it is necessary to take advantage of the needs of those seeking employment in order to secure professional work which is frequently let to the lowest bidder. Engineers in private practice are often criticized because they have not established a scale of charges on a percentage basis as have the architects, but in the offices of leading architects will be found young men who are willing to work for almost nothing for the sake of the experience they hope to gain.

The fact remains that employing engineers are sometimes disposed to pay their men less than their services are actually worth. The code of ethics, adopted by the society by letter-ballot on Sept. 2, 1914, lays special emphasis upon the relation of the engineer to his client and to that of competing engineers, who may be striving to secure the same contract or commission, toward each other, but it makes no mention of the obligations of the engineer as an employer to men of his own profession. It appears to lose sight of the need of guarding against underpaying as well as against underbidding.

The engineer, in some branches, unlike other professional men, is frequently unable to locate in one place until he can become known, even though his reputation may be local. He must go where work is in progress, and, when the particular work on which he has been engaged shall have been completed, he must move on to another place. Periods of unemployment are fatal to steady advancement, while a reasonable prospect of promotion, however slow, is likely to prompt men to accept less than the average compensation for the kind of service rendered. . . .

Perhaps there are too many engineers, but the eagerness of young men to adopt this profession is doubtless due to the indisputable fact that young graduates of engineering schools reach a self-sustaining basis, where they are at least able to support themselves, more quickly than do those of other professions.

Much has been said lately about the general decrease in the registration at engineering schools, and this has apparently been viewed with alarm by their faculties. Your committee does not consider it a bad omen for the profession. There is a need of better engineers rather than of more engineers, a need more particularly of men who are better grounded in the fundamentals of the engineering sciences and who have at the same time acquired some knowledge of the economic or business aspects of engineering work, rather than of men who may have the greatest earning capacity on the day of their graduation.

Joint Committee on Concrete Issues Final Report

SYNOPSIS—Salient points in the final report of the Joint Committee on Concrete and Reinforced Concrete.

The long-awaited revised report of the famous Joint Committee on Concrete and Reinforced Concrete has at last been issued. This report, which is definitely announced by the committee to be its final one, had its first publication in the December, 1916, "Proceedings" of the American Society of Civil Engineers as the report of that society's representatives on the committee. It is, however, signed by all members of the Joint Committee, including the representatives of the other societies. The final report is recorded as having been adopted by the committee on July 1, 1916. It will be presented for discussion to the annual Am. Soc. C. E. meeting at New York on Jan. 17, 1917.

It is probably not necessary to outline the history of the Joint Committee. Suffice it to say that it is composed of 28 members representing the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association, the Portland Cement Association and the American Concrete Institute. The first report of the committee was submitted in December, 1908. That report was revised and brought up to date in November, 1912, so that the present final report is the third one which the committee has brought in. The final report is signed by all the members of the committee, but Edward Godfrey, one of the representatives of the American Concrete Institute, dissents to some portions of the report, as noted hereinafter.

The main impression given in looking over the report for the first time and comparing it with the 1912 report is surprise at the very few changes. The members of the committee, it is well known, have devoted an enormous amount of attention to the revision. It is evident now that this revision was based entirely on the old report and was really a revision and not a reconsideration of the earlier report. In one notable instance the new report is different; it contains a discussion of the flat-slab or girderless floor construction, a construction that was not touched upon in the earlier report. This is the most radical change. There are, however, a number of other changes each of which has its own importance. The report, incidentally, has exactly the same number of pages as the 1912 report; that is, 52 pages of the regular American Society of Civil Engineers standard.

In the first place, the new report leaves out a great deal of the historical references and authorities noted in the old, and its preliminary statement devotes more attention to the precautions necessary for good concrete work. It makes few changes in the paragraphs relating to the corrosion of the metal, to electrolysis, to the effect of sea water or of impurities on concrete. Apparently, noth-

ing worth while along these lines has been discovered in the four years since the first revision took place. The definitions of materials are practically the same, and the provisions for materials quite little changed. Blast-furnace slag, it may be noted, is specifically not recommended for concrete aggregate, but on the other hand, cinders are allowed in reinforced-concrete slabs up to 8-ft. span. Only the structural-steel grade of the Am. Soc. T. M. billet-steel specification is recommended for reinforcement.

Change In Time of Mixing

In the manufacture of concrete the most definite change is the increase in the mixing period, for a machine mixer, from 1 min. in the old report to 1½ min. in the new for ordinary mixers and 2 min. for mixers of two or more cubic yards' capacity. The need for good and thorough mixing is enlarged upon in some detail. The question of water content is touched upon, but definite instructions are avoided. An additional paragraph has been added on the necessary details of spouting concrete. In the paragraph on freezing weather, the use of salt is deprecated. For underwater concreting the drop-bottom bucket is also deprecated.

There is practically nothing new in the section on forms, and there still is no test given by which one may determine whether concrete has set sufficiently to remove its supports or forms. There is very little new in the section on placing of joints, on shrinkage and temperature changes, on fireproofing, on waterproofing or on surface finish, though all these sections have been rewritten in part.

This brings the report to the subject of design, in which only the important changes can be noted here.

Under certain conditions the brackets are considered in span lengths of beams. The overhang width of T-beams is increased from four to six times the slab thickness. The load distribution on oblong slabs is changed in formula, though the new formula produces practically the same numerical results as the old. In continuous beams there is one minor change of coefficients. The bond-strength and reinforcement-spacing section has few changes. The long discussion on diagonal tension and shear, while rewritten in parts, seems to be mainly a justification of the theory of web stresses which was advanced in the earlier report. Mr. Godfrey dissents from this whole section.

The section on columns has some changes, the first of which is that a definition of a column is changed so that it includes compression members in which the "ratio of unsupported [by which the committee undoubtedly means unstayed] length to least width exceeds about four" instead of as in the old report about six. The second change in the column provisions is that there is no reference whatever made to a hooped or banded column that has no longitudinal reinforcement, and the third change is that the unit stresses in hooped columns (with not less than 1% and not more than 4% of longitudinal bars) and (this is added) with hooping steel not less than 1% of the volume of the concrete, shall have a unit stress 55% higher than for straight-rodded columns, provided the ratio of unsupported length of column to diameter of hooped core is not more than 10 (instead of 8 in the old provision). The old percentage was 45%. This particular clause Mr. Godfrey objects to with the claim that it is capable of being interpreted that hooped columns are given an advantage in the matter of unit stresses only below 10 diameters in height. He recommends a special specification for hooped columns and would not recognize the straight-rodded column at all.

In the section on reinforcing for shrinkage and temperature stresses a paragraph has been added calling attention to the necessity for connecting the various parts of the frame of articulated structures in reinforced concrete. This has undoubtedly been added in response to numerous criticisms of the omission of such provision in the earlier specifications.

Flat-Slab Floor Design Taken Up

The provision for flat slabs takes about eight of the standard-size pages. It is stated in such fashion as to make it difficult of comparison with other used methods for figuring the flat slab. Briefly, the method employed is based on the theoretical considerations laid down by John R. Nichol in his paper entitled "Statical Limitations Upon the Steel Requirements of Reinforced-Concrete Flat-Slab Floors," in the "Transactions" of the American Society of Civil Engineers, Vol. 77. By this theory a certain value is obtained by statical calculations for the numerical sum of the positive moment at a midspan section and the negative moment at a column section of a panel. This value is absolutely determinate. Beyond this point, however, the method becomes empirical. The committee distributes this moment in the proportion of three-eighths to the positive moment and five-eighths to the negative moment. It then further distributes the means for resisting the moment by saying that at least 25% of the positive moment should be cared for in a so-called inner section—that is, an area occupying the space between the two outer quarter-points across the slab. The space outside of these quarter-points, known as the outer sections, should care for at least 55% to 70% of the specified moment. In the negative moment at least 20% should be provided for in the midsection and at least 65% to 80% in the column head section.

In the working-stresses section some minor changes have been made. In the tabulation of the various compressive strengths of different mixtures of concrete, according to the mixture and the kind of aggregate, the proportions of mixture are given as cement to total aggregate and not as cement to sand to stone. The compressive strengths, however, are the same. In the safe values permitted, that for bearing has been changed from 32½% to 35% of the total compressive strength. In axial compression, the short concrete pier has been included. In shear, some minor changes have been made in web reinforced beams. In bond, an additional 1% over plain reinforcing bars has been allowed for the bond stress on "the best type of deformed bar."

The new appendix contains only the formulas, which have some typographical changes from the old. The former cement and steel specifications are omitted, reference being made to the proper standards in other publications.

In conclusion the report says:

> The Joint Committee believes that there is a great advantage in the coöperation of the representatives of different technical societies, and trusts that a similar combination of effort may be possible some time in the future, to review the work done by the present committee, and to embody the additional knowledge which will certainly be obtained from further experimentation and practical experience with this important material of construction.

News of the Engineering World

Navy Plans Big Dry Dock at Philadelphia

The United States Navy Department, through the Bureau of Yards and Docks, is asking for bids to be opened Jan. 29, 1917, on a dry dock at the League Island navy yard in Philadelphia, Penn., capable of handling any ship now afloat or under construction. Its main dimensions are as follows:

	Ft
Length over all, outside dimensions..	1,064 3
Length over all, inside dimensions.	1,022 0
Width over all, outside dimensions..	212.5
Width of entrance, mean high water.	132 6
Depth, mean high water......	40 0

The structure is to be of concrete, reinforced where required, and is to be founded on piles where conditions show them to be necessary. The estimated quantities are, roughly: Excavation, 860,000 cu.yd.; concrete, 176,000 cu.yd.; piles, 495,000 lin.ft.; structural steel, 120 tons; reinforcing steel, 750 tons; cast iron, 200 tons.

The Philadelphia dock will be the second 1,000-ft. dock on the Atlantic Coast of the United States, the other being the one under construction by the State of Massachusetts in Boston harbor. The United States Government has a 1,000-ft. dock at Balboa, Canal Zone, and the Canadian Government has one under construction at Levis, opposite Quebec. On the Pacific Coast a Government-subsidized dock over 1,000 ft. long is building at San Francisco, and the navy has another under construction at Pearl Harbor, near Honolulu. All of these large dry docks are developments of the last five years and indicate the growth of the large ship, which must have docking facilities at convenient locations.

Relief Work by Engineers in Southern Flood Districts

Engineers everywhere are justly proud that the gigantic task of furnishing food to the starving Belgians was organized and has been carried on under direction of an American engineer, H. C. Hoover. Comparatively few engineers, however, know that the Corps of Engineers of the United States Army, with its staff of civilian assistants, has recently accomplished relief works on a large scale for the benefit of flood sufferers in the South. In July last, great destitution was caused by the severe storms that swept over the Carolinas, Georgia, Alabama, Florida and Mississippi, and $570,000 was appropriated by Congress to relieve the sufferers. Aside from supplying seed to the destitute farmers, which was done through the Department of Agriculture, the relief work was carried out by the Corps of Engineers.

In this work great care was exercised to prevent pauperization. Those applying for free supplies or medical attention were carefully investigated to determine that they were both destitute and unable to work. Most of the relief money was expended by employing the destitute on roadwork in coöperation with state, county and other local officials. Work on the roads was confined almost entirely to grading and drainage done by hand labor, so that practically all the money expended went direct to the workers. The efficiency with which the work was accomplished was highly commended by Senator Underwood of Alabama in a letter to General Black, Chief of Engineers, in which he says: "The work was splendidly done. The relief was immediate and accomplished the results desired without bringing any demoralization in its wake. Our people were thoroughly satisfied with its accomplishment."

Progress on Lincoln Highway in 1916

In New Jersey, where the Lincoln Highway is entirely hard surfaced, $183,678 was spent for repairs and maintenance in 1916. In Pennsylvania the sum spent was $193,000. During the year, contracts were let in Ohio for permanent surfacing in 10 counties, totaling $775,000, exclusive of the paving of the route through many cities.

The counties of Indiana, where there is no state highway department, spent in excess of $700,000 on improvements of the Lincoln Highway in 1916. Incomplete records of expenditures in Illinois total $335,800. The counties of Iowa are not allowed to issue bonds for roads. Consequently, pavement construction is practically impossible and none exists outside municipal limits. Work in the state has consisted of grading, draining and maintaining the route, and in dry weather the Lincoln Highway is a boulevard from the Mississippi to the Missouri. This work cost almost $1,000,000, including the paving of the city streets that are a part of the highway.

Reports from Nebraska indicate that over $367,300, raised largely by the counties, has been expended in Lincoln Highway improvement and maintenance in 1916. The counties through which the highway passes in Nebraska are large and sparsely populated, and sums sufficient to construct hard-surfaced roads are beyond their reach. Yet no difficulties are encountered in dry weather in driving through Iowa and Nebraska; five years ago it was an adventure.

In Wyoming the amount spent on the Lincoln Highway in the past two years has been more than $10 per capita of the population residing along the route. If $10 per capita was raised for road improvement along the Lincoln Highway from New York City to Pittsburgh, Penn., a distance approximately equal to that across Wyoming, the resultant funds would surface the entire Lincoln Highway with concrete from New York to San Francisco twice over.

The Lincoln Highway in Utah, particularly that section lying next to the Nevada line, is the worst section to be encountered anywhere between the two coasts. The improvement of this road presents an insurmountable difficulty to the people of the state. Its cost is far beyond their reach. About the same conditions exist in Nevada, where for 12 mi. in Churchill County the road is through

Fallon Sink, a dried-up lake. For improving this section the Willys-Overland Co. (of Detroit) contributed $50,000, dependent upon the State of Nevada raising a like sum.

A very large part of the Lincoln Highway in the State of California is state highway, and as such has been receiving the benefit of its proportion of the $18,000,000 provided by state bond issue for permanent construction of the state highways. A few sections in California not yet permanently constructed in accordance with the statewide plan will be taken care of with the money provided through the $15,000,000 bond issue that has just been passed in that state.

Baltimore To Continue Repaving Work

The City of Baltimore, which has been engaged for several years in extensive repaving of a large part of its streets, will continue the work during 1917, spending probably about $2,000,000. Bids for a large amount of paving will be advertised for, about Jan. 15, 1917, the contracts ranging in size from $5,000 for alley work to $200,000 for street work, giving opportunity for both large and small contractors. The city will have available to expend on paving in the next few years about $8,000,000. The work of paving is in charge of the city's Paving Commission, of which R. Keith Compton is Chairman and Consulting Engineer.

Chicago Transit Commission Report

The report of the commission appointed to recommend a plan for rapid transit for the City of Chicago, noted in *Engineering News* of Dec. 7 and 14, was submitted to the City Council on Dec. 21. As previously announced, the commission has laid out a nine-year program calling for an expenditure of $100,000,000 for construction and equipment. In this program is included the construction of a double-track rapid-transit subway 6 mi. in length and a 5-mi. subway for street surface cars, to relieve congestion in the business district. Extensions to the elevated-railway lines of the city will be made, aggregating 65 mi. of single tracks. The network of street railways will be increased by 150 mi. of new line, and 111 mi. of old lines will be reconstructed. Eventually, the rapid-transit subway will have a total trackage of 58 mi.

The commission recommends that a corporation be organized under municipal control to operate all the passenger transportation of the city—surface, elevated and subway—and give universal transfers. Among the first work to be undertaken will be the extension of the present elevated-railway system by the construction of additional lines, and the building of new lines so as to give three through north-and-south routes. There will be one four-track line through the business district and two double-track lines in the western part of the city. On the elevated loop the grades will be separated at the intersection of the east-and-west and north-and-south lines to increase the safety of operation and avoid delays. The present elevated loop will be extended, as the central business district now reaches out beyond the old loop district. As part of the four-track elevated route through the business district a double-track subway is to be built under State St. from 18th St. to Chicago Ave. Other subways will be built to the two east-and-west elevated lines, with a connecting terminal loop. These subways will be at a different level from the north-and-south subways.

At a later date an extension will be added to form an independent north-and-south subway line from 63d St. to Belmont Ave. A street-car subway to relieve congestion in the business district will be located under Michigan Ave., and others will be constructed for the east-and-west line, a connecting loop passing under the north-and-south subway.

ENGINEERING SCHOOLS

Massachusetts Institute of Technology

During 1916, President Maclaurin of the Massachusetts Institute of Technology devoted much effort to the establishment of a larger endowment fund. As a result the total of gifts and legacies secured during the year amounted to $5,796,293. Notable among the items making up this sum is an anonymous gift of $2,500,000, which was conditional on $1,500,000 secured from other sources. The $900,000 legacy for the C. H. Pratt School of Naval Architecture, which sum had been in litigation, was paid. An anonymous gift of $300,000 was made for the establishment of a school of chemical-engineering practice.

University of California

The first of the new buildings provided by the $1,800,000 bond issue, voted two years ago by the people of California, will be placed in service in January. This is Wheeler Hall, a $727,000 white-granite classroom building. By March, the new $1,185,000 university library will be completed; the first part of this, costing $685,000, was built in 1910. During the summer the second unit in the new agriculture group and the first unit in a chemistry group, costing $375,000 and $220,000, will be ready.

NOTES

The Building of Wooden Vessels has not yet ceased to be a considerable industry, according to recent statistics of the Bureau of Navigation, Department of Commerce. There are at present under construction, or contracted for, 116 vessels of over 500 gross tons, making a total of about 160,000 tons.

Track Elevation at Spokane, Wash., by the Northern Pacific Ry., will extend for a distance of 2 mi. through the city. The tracks will be raised 12 to 16 ft., and carried on solid fill between concrete retaining walls, with about 20 bridges over the streets. The passenger station is involved in the change. There are 12 to 15 tracks at some parts of the line and the width of the roadbed will be from 85 to 225 ft. The work will be done without interrupting traffic, which amounts to about 40 regular trains daily. The plan is to build the north wall and then a trestle along the north side from which a fill will be made wide enough for two main tracks. Traffic will then be diverted to these tracks, and the filling continued to the south wall.

Winners of a Prize Contest for articles, written by undergraduates and recent graduates of technical colleges and universities are announced by the Engineers' Subdivision of the Chicago Association of Commerce as follows: First prize of $50 awarded to Harvey T. Hill, Chicago, a graduate of Pennsylvania State College, 1915. The subject of the paper was "Engineering and Civil Progress." Second prize of $30 was

awarded to Leo Shippy, Ames, Iowa, a junior at Iowa State College, who wrote on the subject of "The Engineer of the Future." Third prize of $20 was awarded to H. M Kistler, Pittsburgh, Penn., a graduate of Pennsylvania State College, 1916, his subject also being "The Engineer of the Future." Eleven universities were represented in the contest. Prizes were offered for the best articles on any one of three subjects as follows: (1) "Engineering and Civic Progress," (2) "The Engineer of the Future," (3) "The Business Relation of the Engineer to the Commercial World." The judges of the contest were, Prof. F. H. Newell, University of Illinois; Dean John F. Hayford, Northwestern University, and John W. Alvord, Consulting Engineer, Chicago.

The Nature of Color in Water was the subject of a somewhat technical but interesting paper by Thorndike Saville, presented to the meeting of the New England Water-Works Association in Boston on Dec. 13. Investigations indicate that most color in water is colloidal in its nature. The author held out the hope that methods of removal better than those now in common use might result from this knowledge.

The Panama Canal Channel through Culebra Cut, according to the Panama Canal "Record" of Dec. 20, is now in better condition than ever before. The cut which has been dredged through the slides has a minimum depth of 33 ft. and the least width of a channel of 30-ft. depth is 180 ft. at the point opposite the rock known as Gibraltar. This rock projects into the channel about 110 ft. and extends along the channel about 200 ft. It has been blasted away until it now rises only about 30 ft. above the water. The dredges "Corozal" and "Paraiso" are at work on the removal of this rock and are dredging behind it to prevent its being pushed forward. Work of the dredging force of the canal on Sundays and holidays was discontinued on Dec. 3, except for the force engaged in blasting at Gibraltar. Since June 1, 1915, dredging has been carried on in the cut continuously with three shifts a day, including Sundays and holidays until Dec. 3.

PERSONALS

S. Camden Miller, Operating Engineer of the Canton Bridge Co., Canton, Ohio, has resigned, effective Feb. 28.

B. J. Simmons has been appointed Division Engineer of the Atchison, Topeka & Santa Fe Ry. at Needles, Calif., succeeding W. L. Bradley, transferred.

W. B. McCabe, M. Inst. C. E., has resigned as Chief Engineer of the Corporation of Calcutta, India, after 13 years' service. He was formerly Water Engineer of Dublin, Ireland.

Kenyon Riddle, recently City Engineer and former City Manager of Abilene, Kan., has been appointed Secretary of the Kansas Automobile Trade Association, with headquarters at Topeka, Kan.

O. A. Tislow, Structural Engineer, has resigned from the employ of Albert Kahn, Architect, Detroit, Mich., to undertake flour-mill building design for the Nordyke & Marmon Co., Indianapolis, Ind.

F. O. Swoboda, Assoc. Am. Inst. E. E., Consulting Electrical and Mechanical Engineer, of Pittsburgh, has been appointed to make a preliminary investigation of the street-lighting system of the city.

Robert H. McCormick, M. Am. Soc. C. E., has resigned as City Engineer of Detroit, Mich., after 16 years in that office. He has been connected with the office of the city engineer for a total of 34 years.

George P. Van Vliet, for the past two years Assistant Engineer with the Division of Sewerage, Cincinnati, Ohio, has resigned to accept a position with the Robinson Clay Products Co., Akron, Ohio, as Sales Engineer.

J. E. Bebb, Assoc. M. Am. Soc. C. E., recently Office Engineer of the Duluth, South Shore & Atlantic Ry., at Duluth, Minn., has been appointed Assistant Bridge Engineer of the Michigan Central R.R., with headquarters at Detroit, Mich.

George C. Hicks, Jr., M. Am. Soc. M. E., for the past 15 yr. Vice-President and Engineer of the P. H. & F. M. Roots Co., of Connersville, Ind., has retired from that company. He expects to take a six months' vacation before engaging in a new enterprise.

G. H. Bayles, M. Am. Soc. C. E., Consulting Engineer, Atlanta, Ga., has accepted a position as Office Engineer of the construction department of the Chile Exploration Co., of New York City, and is now at Chuquicamata, Chile, where his headquarters will be.

Howard G. Borden, a Junior Assistant with the New York Public Service Commission on subway work, has been commissioned Second Lieutenant, Corps of Engineers, U. S. A., being one of the five civilians who were recently selected by open examinations. He was born in Fall River, Mass., Jan. 13, 1891, and was graduated from the Massachusetts Institute of Technology in 1914.

Harold Ward Sibert, a chemist with the People's Gas Co., Chicago, Ill., a son of Brig.-Gen. William L. Sibert, former member of the Panama Canal Commission, is one of the five civilians commissioned Second-Lieutenant, Corps of Engineers, U. S. A. He was born at Bowling Green, Ky., May 9, 1892, and was graduated from Cornell University in mechanical engineering in 1914.

Thomas F. Farrell, recently with the engineering staff under the Governor of the Panama Canal, is one of the five civilians to be commissioned Second-Lieutenant in the Corps of Engineers, U. S. A. He was born at Brunswick, N. Y., Dec. 3, 1891, and was graduated from Rensselaer Polytechnic Institute in 1912. He was with the Panama R.R. in 1913 and 1914 and since then has been on work in connection with the canal.

Kenneth S. Jones, of the engineering staff of the Illinois Central R.R., has been commissioned Second-Lieutenant, Corps of Engineers, U. S. A., being one of the five civilian appointees, noted elsewhere in these columns. He was born at Norfolk, Va., Feb. 18, 1888, and has graduated three times from the University of Virginia—in arts, law and civil engineering (1915). He practiced law from 1910 to 1913; since then he has been with the engineering departments of the Pennsylvania, Norfolk & Southern and Illinois Central railroads.

Ernest L. Osborne, recently with the Westinghouse Church Kerr & Co., New York City, is one of the five civilians who have been commissioned Second-Lieutenant, Corps of Engineers, U. S. A. He was born in Denver, Mo., June 15, 1889. He was graduated from Sheffield Scientific School, Yale University, in 1912, and after a short experience in engineering work was commissioned Second-Lieutenant, Coast Artillery Corps, U. S. A. He resigned the following year and entered the Massachusetts Institute of Technology, where he was graduated in 1914. Since then he has been an instructor at Yale and a Junior Engineer with the New York Public Service Commission on subway work.

C. K. Clarke, City Manager, of Tucson, Ariz., has been appointed Chief Engineer of the Imperial Irrigation District, Calexico, Calif., succeeding Charles R. Rockwood. Mr. Clarke is a former Superintendent of Water Company No. 1 and Chief Engineer of the Imperial Valley irrigation system under the California Development Co. Afterward he was Division Engineer of the Southern Pacific Co. and was in direct charge of the work of making the closure in the Colorado River break into the Imperial Valley, following the disastrous floods of 1910. He is an intimate friend of Harold Bell Wright, the author, and supplied much of the technical information upon which Mr. Wright's novel "Barbara Worth" is founded. For the past two years Mr. Clarke has been City Manager of Tucson. His experiences here were described in an editorial in "Engineering News," Apr. 20, 1916.

James C. Travilla, of St. Louis, Mo., has been appointed Consulting Engineer of the Dunn Wire-Cut-Lug Brick Co., of Conneaut, Ohio. In March, 1916, he was appointed Consulting Engineer of St. Louis County, Missouri, to take charge of the construction of a $3,000,000 road system. Owing to legal complications the bonds have not been issued, and the position of Consulting Engineer was declared illegal, the courts deciding that the work must be done by the County Engineer. Mr. Travilla is a former Street Commissioner of St. Louis and recently had charge of construction of a $1,000,000 road system for Tarrant County, Texas. He is a graduate of the University of Pennsylvania and went to St. Louis to join the engineering staff of the Missouri Pacific Ry. Later he was Assistant Engineer in the Water Department of the city and subsequently in the Street Department.

Clarence W. Hubbell, M. Am. Soc. C. E., Consulting Engineer, of Detroit, Mich., has been appointed City Engineer of Detroit, by Commissioner of Public Works, George H. Fenkell, to succeed Robert H. McCormick, resigned, as noted elsewhere in these columns. Mr. Hubbell was graduated from the University of Michigan in 1893. From 1898 to 1907 he was Civil Engineer for the Board of Water Commissioners of Detroit. He served in the Philippine Islands in turn as Principal Assistant Engineer on the construction of new sewerage and waterworks systems for the City of Manila; as City Engineer for the City of Manila, and finally as Chief Engineer of the Board of Public Works, Philippine Islands. He returned to the United States in July, 1914, and to date has conducted a consulting practice in sanitary engineering at Detroit. During this period he was retained by the City of Detroit as consulting engineer on preliminary studies for sewage disposal. The salary of the City Engineer is $4,000 per annum.

OBITUARY

Charles W. Archinal, for many years an engineer in the employ of the Trenton branch of the American Bridge Co., died recently. He was a member of the Trenton Engineers' Club.

Peter T. Shelby, a retired official of the Great Northern Ry., who served under Gen. J. F. Casement, contractor for the construction of a large part of the Union Pacific R.R. in the late sixties, died recently in Cleveland, Ohio.

William E. Leard, a manufacturer of New Brighton, Penn., died Dec. 17, aged 74 years. Shortly after the Civil War he engaged in the manufacture of drill presses at Cincinnati, Ohio. In 1882 he built a plant at New Brighton, Penn., for the manufacture of strap joints, connecting rods, forgings, etc.

C. P. Allen, former Chief Engineer of the Denver Union Water Co., Denver, Colo., died from pneumonia at his home in that city Dec. 19. He was born at Moore's Fort, N. Y., Dec. 27, 1842. He went to Denver in 1874 and entered the service of the Denver Water Co., with which company and its subsequent successors, the Denver City Water Co. and the Denver Union Water Co., he remained until 1900. A large part of the construction work done by the original company was under his supervision. After his retirement from the water-works company he entered private practice as a consulting hydraulic engineer and was associated with the construction of water-works at Leadville, Fort Collins, Greeley and Pueblo. He also designed and constructed a water-supply system for the Colorado Fuel and Iron Co. at Pueblo. He served in a consulting capacity for the City Public Utilities Commission in making a report on the cost of construction of a municipal water-works for the City of Denver. In 1912 he was a member of the State Highway Commission. He is survived by two sons, one of whom is William F. Allen, a Denver civil engineer, who has been associated with his father, eight daughters and a widow.

ENGINEERING SOCIETIES

SOCIETY OF AUTOMOTIVE ENGINEERS.
Jan. 11. Annual meeting in New York City. Secy., C. F. Clarkson, 129 West 39th St., New York.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION.
Jan. 15. Fourth annual meeting in New York City. Secy., O. S. King, 120 Broadway, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at Society House, New York City. Secy., Charles Warren Hunt, New York.

INDIANA ENGINEERING SOCIETY.
Jan. 18-19. Annual meeting in La Fayette, Ind. Secy., Charles Brossmann, 1616 Merchants' Bank Bldg., Indianapolis.

WESTERN BRICK MANUFACTURERS' ASSOCIATION.
Jan. 20. Meeting in Kansas City, Mo. Secy., G. W. Thurston, 416 Dwight Building, Kansas City.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 23-25. Annual meeting in Montreal, Can. Secy., C. H. McLeod, 176 Mansfield St., Montreal.

ILLINOIS SOCIETY OF ENGINEERS.
Jan. 25-26. At Chicago. Secy., E. E. R. Tratman, Wheaton, Ill.

OHIO ENGINEERING SOCIETY.
Jan. 31-Feb. 2. Annual meeting. Ohio State University, Columbus, Ohio. Secy., John Laylin, Norwalk, Ohio.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 7-9. Midwinter convention in New York City. Secy., F. J. Hutchinson, 33 West 39th St., New York City.

MINNESOTA SURVEYORS' AND ENGINEERS' SOCIETY.
Feb. 7-9. Annual meeting in Minneapolis.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

WISCONSIN ENGINEERING SOCIETY.
Feb. 15-16. At Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 19-22. Meeting in New York City. Secy., Bradley, Stoughton, 29 W. 39th St., New York City.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

The Canadian Society of Civil Engineers holds its annual meeting Jan. 23 to 25 in Montreal. The secretary is C. H. McLeod, 176 Mansfield St., Montreal.

The National Association of Builders' Exchanges of the United States of America will hold its sixth annual convention in Atlanta, Ga., Feb. 13 to 15. The secretary is I. H. Skates.

The Chemists' Club of Youngstown was recently organized with the following officers: President, Edwin G. Pierce; treasurer, H. E. Moyer; secretary, Carl W. Weesner, Carnegie Steel Co.

The Minnesota Surveyors' and Engineers' Society will hold its annual meeting Feb. 7 to 9 in Minneapolis at the Hotel Radisson in conjunction with the annual meeting of the Civil Engineers' Society of St. Paul. Coincidentally the Minnesota Joint Engineering Board will meet.

The American Association of State Highway Officials held its annual meeting recently in St. Louis, representatives of thirty-one states being present. The new officers are: President, George P. Coleman, West Virginia; vice-president, A. B. Fletcher; secretary, J. H. Pratt, North Carolina; treasurer, F. F. Rogers.

The American Railway Engineering Association—The nominating committee has submitted the following nominations for officers for the coming year: President, John G. Sullivan, chief engineer, Western Lines, Canadian Pacific, Winnipeg, Can.; vice-president, Earl Stimson; treasurer, George H. Bremner; secretary, E. H. Fritch, Chicago, Ill.

The American Wood Preservers' Association will hold its thirteenth annual convention in New York City, Jan. 23 to 25 at the Hotel Astor. Among the matters to be discussed are "Service Tests of Ties and Structural Timber," and "Grouping Wood for Preservative Treatment." An informal banquet will be held at 6:30 Wednesday, Jan. 24.

The American Institute of Electrical Engineers meets in Pittsburgh Jan. 12, the subject under discussion being "Braking Electric Vehicles by Regeneration"—that is, using the energy generated on downgrades to apply brakes to the vehicles—by R. E. Hellmund, of the Westinghouse Electric and Manufacturing Co. H. W. Buck, President of the Institute, will preside.

The Society of Automotive Engineers will hold its annual meeting Jan. 11 at the Engineering Societies Building, New York City. Following the presentation of a number of papers on aëroplane, automobile and tractor engines, the society will adjourn to the New Amsterdam Roof to witness "Ziegfeld's Midnight Frolic," the entire seating capacity having been purchased by the society.

The Engineers' Club of Cincinnati held its annual banquet and election of officers at the Literary Club on Dec. 21. A. S. Wilson, Professor of Electrical Engineering of the University of Cincinnati, was elected president and E. A. Gast was reëlected secretary and treasurer. The address of the evening entitled "Concrete Bridges and Viaducts in Cincinnati" was delivered by Frank L. Raschig, the retiring president.

The Florida Engineering Society was organized in Jacksonville Dec. 23, with L. D. Smoot, Commissioner of Public Works, of Jacksonville, President; W. P. Darwin, Jacksonville, and R. E. Chandler, Gainesville, vice-presidents; J. R. Benton, Gainesville, secretary, and H. D. Mendenhall, Lakeland, treasurer. The charter membership list numbers 84, the qualifications for membership being similar to those of the national engineering societies. It is stated that the chief object of the newly organized society is the elimination of objectionable engineering practitioners.

The Florida Association of Architects has congratulated the new Florida Engineering Society, and invited it to coöperate with the association in Tampa, Feb. 8 to 10. The letter of E. A. Ehmann, secretary of the architects' association concludes with: "We shall be glad if you will appoint a committee to meet with us in Tampa, in order to give your and our organizations the much desired opportunity to discuss ways and means to work together harmoniously in our mutual efforts to improve the scientific and practical efficiency of the professions of engineering and architecture."

American Society of Agricultural Engineers—Farm structures and equipment and farm machinery (particularly in regard to tractors) were the leading subjects discussed at the tenth annual meeting of the American Society of Agricultural Engineers. The meeting was held at the Sherman Hotel, Chicago, Dec. 27 to 29, with a registered attendance of over 100 members and visitors. Other subjects included farm planning, drainage and irrigation, and electric power and light for farms. There was also a group of papers on education in agricultural engineering. The President for 1917 is E. H. McCormick, Office of Public Roads and Rural Engineering, Washington, D. C. Secretary, C. K. Shedd, Iowa State College, Ames, Iowa.

Appliances and Materials

New Waterproofing Compounds

A new line of membrane waterproofing compounds is being put out by the Richmond Waterproof Products Co., 30 Church St., New York City, under the trade name "Monarch Cements." Several consistencies are offered, designated as "paint," "x," "xxx"" and "xxxx"; the material consists of inert filler, asphaltic binder and more or less oil and coloring matter. These compounds are virtually the older A. F. Roofing Co. cements adopted for a new use, that concern having been absorbed. It is claimed that sufficient color can be introduced to give pronounced reds, greens, yellows, etc., without changing the adhesive and water-repellent qualities of the compound.

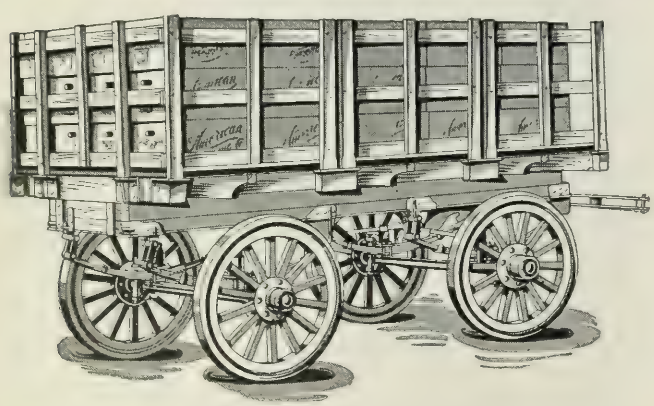
The "paint" is used on steelwork where it is desired to protect with a closely adherent fume- and moisture-proof coat. The "x" cement is largely intended for flashing, expansion joints, crack filling, etc.; "xxx" and "xxxx" are to form stiff membranes. All the cements are applied hot, the heavier ones with a hot or greased trowel. Good adhesion to wet masonry, etc., is reported; recent tests in the New York Central Testing Laboratory showed 92 lb. per sq.in.

While the company recommends placing the membrane between the inleaking water and the structure to be waterproofed, yet it claims that the adhesion secured even under the most unfavorable conditions is sufficient so that it stops inflow as an internal, unsupported, plastered-on membrane. The company sells these materials in the open market and contracts for their installation in difficult cases to demonstrate their utility. The paint sells for $1.40 per gal. The cements sell for from 8 to 6½c. per lb., depending on the amounts.

* * *

Rubber-Tired Trailer

The destruction of expensive pavements by steel-tired trailers has drawn attention to the field for rubber-tired vehicles of this kind. In the accompanying sketch is shown



NEW TROY RUBBER-TIRED TRAILER

a new design of the Troy Wagon Works, of Troy, Ohio. This was built for the American Brewing Co., of Detroit, and has a capacity of 2½ tons as fitted with an express body. The wheels have 3-in. rubber tires. The trailer is intended for running in only one direction.

* * *

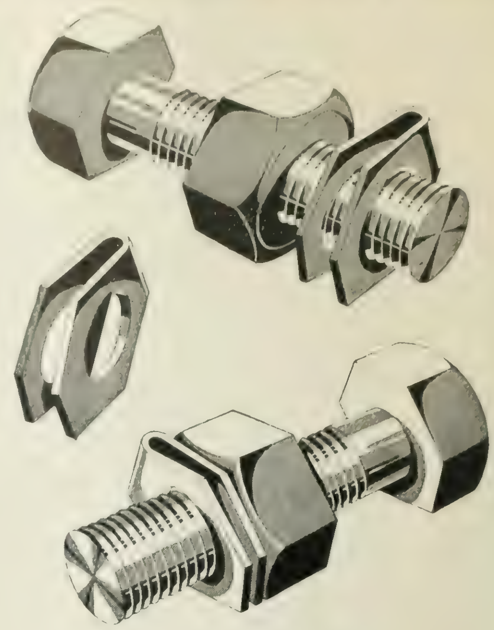
Compressed-Air Meter

A portable compressed-air meter for use with rock drills, etc., has been developed by the Denver Rock Drill Manufacturing Co., of Denver, Colo. It is of positive-displacement type with a piston moving back and forth in a cylinder, the exhaust going to the tool tested. A counter registers the number of strokes; combining the number of strokes, displacement, pressure and temperature gives the amount of free air supplied.

* * *

New Spring Nut-Lock

The nut-lock shown herewith consists simply of a steel plate punched with two holes and then bent to a U-shape so that the two holes are opposite but slightly eccentric. This is done in a die press with one operation. When the nut-lock is screwed upon the bolt, the holes are pulled into concentric position, thus causing a direct pull upon the outer leg and a push upon the leg next the nut. This force is exerted at the root of the threads. There is also a lateral force due to the compression of the U-plate when it is screwed home against the nut. This device is of general application and has been tested with satisfactory results on machinery, au-



SPRING NUT-LOCK

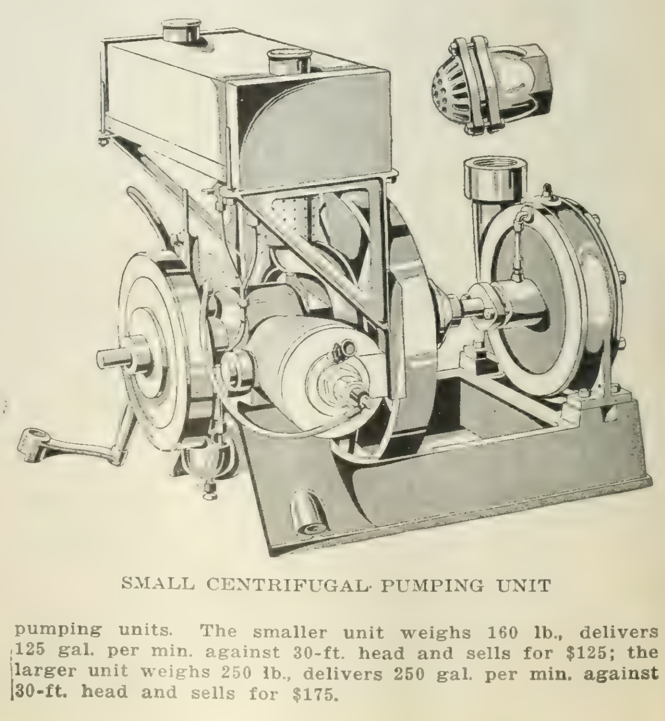
tomobiles, locomotives and track bolts. It is being introduced by the Spring Nut-Lock Co., of 608 S. Dearborn St., Chicago, and a contract for its manufacture has been placed with the Stowell Mfg. Co., of Milwaukee, Wis.

* * *

Small General-Utility Gasoline Motor

The "Pormo" portable gasoline engine, formerly sold by the Portable Power Manufacturing Co., of Chicago, is now manufactured by the Aerothrust Engine Co., Laporte, Ind. (with which the former concern has been merged), and is built in two sizes—3 hp., 2½-in. bore, 2¼-in. stroke; and 5 hp., 3-in. bore and 3½-in. stroke. It is of the two-cylinder opposed type and is mounted on a four-legged base. One man can move it about.

This concern uses these engines on special bedplates with 2- and 2½-in. centrifugal pumps, to make handy portable



SMALL CENTRIFUGAL PUMPING UNIT

pumping units. The smaller unit weighs 160 lb., delivers 125 gal. per min. against 30-ft. head and sells for $125; the larger unit weighs 250 lb., delivers 250 gal. per min. against 30-ft. head and sells for $175.

Engineering News

VOLUME 77 — JANUARY 11, 1917 — NUMBER 2

Willamette Pacific Railroad; A New Line Through the Coast Range

By W. P. Hardesty*

The one natural water-grade route connecting the interior of Oregon with the Pacific Ocean is that down the Columbia River. This route has long been occupied by a railroad. However, besides the mouth of the Columbia River there are several bays along the Oregon coast affording access to ships of limited draft, which are susceptible of improvement to provide facilities for larger vessels. The connection of these bay districts by rail with the great interior, including the Willamette Valley and Portland, is an important step in the development of the country, more especially as the railroads must traverse virgin country rich in various resources. The Willamette Pacific R.R. is the latest, and also the most interesting from an engineering standpoint, of the railroads reaching the Oregon coast. The company was incorporated to build a road from Eugene, on the main line of the Southern Pacific between San Francisco and Portland, lying 123.7 mi. southerly from Portland to Coos Bay, which is about two-thirds the way from the mouth of the Columbia southerly toward the Oregon-California line, lying southwest of Eugene. The length of line to Marshfield, the Coos Bay terminus, is 121.6 mi. The road runs nearly west from Eugene for about 70 mi. until the coast region is reached, then turns southerly and proceeds (at a distance of from 3 to 6 mi. back from the ocean shore) to Marshfield.

The first 17 mi. west of Eugene is over the flat Willamette Valley. Then begins the ascent of the Coast Range. With some development the line reaches the site for Tunnel No. 1, piercing the backbone of the range. This tunnel is 2,489 ft. long, and the easterly end is on an 8° curve. At the westerly end of the tunnel the summit grade elevation of 578.5 ft. above sea level is reached, a climb of only 178 ft. from the floor of the valley. There is a continuous descent for the next 8 mi. (to about M.P. 30), a drop of 186 ft., after which a slightly undulating grade is used. Approaching the bridge at M.P. 35, the first crossing of the unique Siuslaw River is made. This stream is followed for nearly 35 mi., being crossed seven times. The Siuslaw for a long distance flows over a bed of ribbed sandstone, with no addition of sand, gravel or earth. Tidewater reaches up the narrow valley or cañon of this river for some 20 mi. from the ocean, to about M.P. 56. At M.P. 58 is the old settlement of Mapleton, long the connecting point between the stage trip from interior Oregon and the voyage by launch or boat the remainder of the distance to the sea. The Siuslaw River gradually widens into a bay; above the upper end of this, the railroad crosses to the southerly side on a drawbridge and runs nearly parallel to the coast. The natural route is along a string of fresh-water lakes, surrounded by wooded ridges. These lakes are slightly higher than the ocean and drain into it by connecting outlets. Lakes Tsiltcoos and Tahkenitch are most noteworthy, being followed for about 15 mi., and the various arms are crossed on trestles. These two lakes are separated by an isthmus, requiring a low summit in grade.

FIG. 1. VIEW LOOKING NORTH FROM TUNNEL NO. 2, WILLAMETTE PACIFIC R.R.

At about 90 mi. from Eugene the Umpqua is approached. This is one of the largest rivers in Oregon, and it heads on the Cascade Range, cutting entirely through the Coast Range. The railway crosses the estuary of this river on a steel structure over a quarter

*Portland, Ore.

¼ a mile long, between the stations of Gardiner and Reedsport.

The line continues on southward, passing through the low divide south of the Umpqua to reach the next series of lakes by a summit cut and a tunnel 1,183 ft. long. After passing North Lake and Ten Mile Lake (some miles in length) another drainage divide is passed and Coos Bay is reached. Nowhere on this stretch of over 50 mi. along the coast is a grade elevation of over 78 ft. above low tide required, due to the frequent use of tunnels.

Coos Bay is crossed on a steel structure with pile-trestle approaches aggregating almost a mile in length. The cities of North Bend and Marshfield are thus reached, lying on the southwesterly side of the bay.

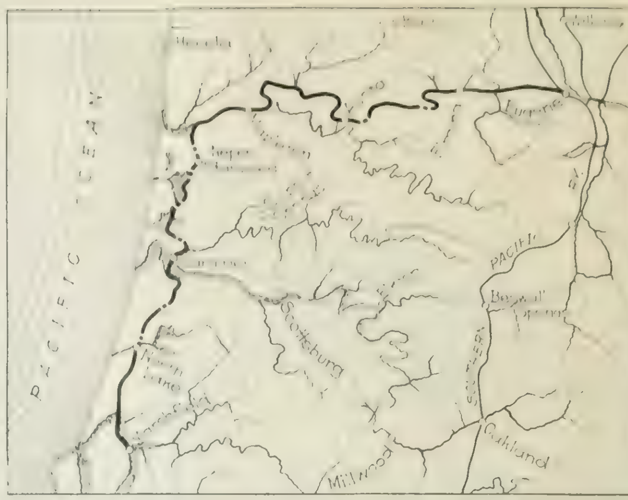


FIG. 2. MAP OF PART OF OREGON, SHOWING WILLAMETTE PACIFIC R.R.

Construction Features

This railway was intended primarily as a branch line or feeder of the Southern Pacific. Unusually rigid requirements have resulted in a road really adapted to forming part of a main line, if it should ever be desired to extend it down the coast into California.

The standards of construction fixed maximum curves at 8° (with two exceptions of 10° curves); maximum grades 0.6%, with compensation on curves varying from 0.035% per degree up to 3° to 0.050% per degree for the 10° curves. The track is superelevated for a speed of 45 mi. per hr. up to curves of 6°, for 35 mi. on 8° curves and 25 mi. on 10° curves. All curves of 2° and sharper are spiraled with Hood's easement curves. Bridges and trestles are designed for the same loading as on the main line of the Southern Pacific. The roadbed is 18 ft. wide in fills and 20 ft. in firm cuts, but in places as much as 25 ft. in sand cuts, because of drifting in.

The materials encountered in grading were mostly clayey soil on the east side of the summit, while on the west slope much of the excavation was in sandstone,

FIGS. 3 TO 6. CONSTRUCTION VIEWS OF THE WILLAMETTE PACIFIC R.R. THROUGH VIRGIN TIMBER COUNTRY

soft and crumbly sandstone and also ordinary sand. Slopes varied from ½ on 1 in sandstone to 1 on 1 in firm earth and loose rock and to 1¾ on 1 in loose sand. Embankments were all built with 1½ on 1 slopes.

Owing largely to the frequent use of tunnels, and also because the location was exceedingly carefully and closely made to secure the proper balance of quantities, the maximum grades and the grading were lighter than might be expected. The following were the total quantities of different classes of materials:

	Cu.Yd.
Earth	2,439,716
Cemented material	660,230
Loose rock	97,959
Shale and similar rock	2,904
Sandstone	821,810
Soft sandstone	823,685
Boulders	100,712
Other solid rock	11,464
Total	4,958,480

The deepest fill was 51 ft., the highest cut 63 ft., the largest cut 108,526 cu.yd. and the largest fill 92,578 cu.yd.

Tunnels Frequently Constructed

In all, there are nine tunnels, 475 to 4,183 ft. in length. Their total length is 14,001 ft., or 2.65 mi. Tunnel No. 1 is at the summit of the Coast Range; No. 2 is on the westerly slope, while all the remainder are on the stretch of railway parallel to the coast. The tunnel cross-section used is the standard of the Southern Pacific, giving a net size of 17x22 ft. The material encountered was usually a sandstone, often soft or given to "slacking" when exposed to the air, so that timbering followed closely.

The timbering is according to the Southern Pacific standards. Timber sets of 10x14-in. fir with three-segment arches were used. The posts each rest on separate mudsills. No wall plates are used, and the tops of the posts are fitted to the inclined segments by wooden dowel pins. The top segments are placed and the joints blocked from the roof until in correct position and tight. By this method each timber set is entirely independent of the others and may be removed and replaced, sill and all. Lagging was used as required. In bad ground the usual spacing of 4 ft. c. to c. between sets was reduced to 3 or 2 ft.

It was the original intention not to line any part of the tunnels with concrete, but this was changed during construction so that in most places a concrete portal and lining extends in 50 to 100 ft. from each end. The face of the lining is flush with that of the posts, with a full circular arch. Each concrete portal was formed with the usual parapet bulkhead, with longitudinal step-down walls for retaining the earth at the sides.

Trestle Construction

Fir-timber trestles were used at many crossings of gulches and water and as approaches to steel structures. They are of standard five-pile bents with 15-ft. spans. The highest is a four-story trestle, used at a creek crossing near the easterly end of the summit tunnel.

The approach to the Coos Bay bridge is a ballasted-deck trestle, about four-fifths of all the piles of which are of cedar, and the remaining one-fifth of creosoted Oregon fir. The caps and bracing are of cedar, while the stringers and the rest of the deck structure are of fir. On the stringers is laid a floor of 3x12-in. plank; on this is placed roofing paper, followed by a coat of asphalt, and then 15 in. of crushed gravel ballast, 8 in. being under the ties.

The cedar piles of the trestle approaches to the Coos Bay bridge are protected against the teredo and other marine borers as follows: A casing of concrete is built around each pile from about 3 ft. below the bottom to about high tide. Where this line came on the bracing, the latter was also protected by the concrete covering.

FIG. 7. SEVENTH CROSSING OF THE SIUSLAW RIVER

The total length of wooden trestles used on the road was 28,720 ft. or 5.44 mi. On all trestles the points of contact of the members were first coated with carbolineum.

Along the string of lakes near the coast, alluvial beds of much depth were found, so that piles of great length were necessary. Some ran as much as 138 ft. after the cutoff, which is believed to be the record for single piles. In order to provide greater bearing at very soft places, bents of seven and even nine piles were used.

Steel Bridges

The western side of the Cascades in Oregon is well watered, so that frequent stream crossings were necessary. In all, there are 31 steel bridges, varying from 60 to 2,208 ft. in length. The total length of these structures is 8,134 ft., or 1.54 mi. These contain 9,100 tons of structural steel, while the substructure parts required 10,000 cu.yd. of concrete.

The Long Tom River is crossed four times, Wild Cat Creek seven times, Siuslaw River seven times, Umpqua River and Coos Bay each once. Spans of standard design were used for the bridges where possible, but some special spans were required because of local conditions. The largest structures were required in crossing the three estuaries on the section running down the coast—namely, Siuslaw River, Umpqua River and Coos Bay.

The Siuslaw drawbridge consists of two 200 ft. through pin-connected spans and a 286 ft. swing span, making a total length of 695.6 ft. The pivot pier varies from 29.7 ft. at the base to 26 ft. in diameter at the top. The track elevation is about 26.5 ft. above low tide.

In building the pivot pier for each of the drawbridges, built-up sheetpiling in three layers of 4x12 in. was first driven. A steel guiding frame was used to maintain the circular shape, and a steel arc or hoop was placed on the outside to hold the sheetpiling against the guiding frame. The excavation to the required depth for the bottom of the concrete was then made with a bucket dredge and a special type of sand ejector, after which the piling foundation was driven, with the piles averaging about 3½ ft. c. to c.

In pouring the concrete for the piers of all these bridges the Southern Pacific practice was followed. The piles were not cut off at the base of the concrete, but at about extreme low water, the ends thus being embedded in the concrete. The reasons for this are that the joints between different pourings of concrete (12 hr. or often several days apart) are difficult to make so as to secure a good bond, especially where they come under the water. The embedded piles resist the tendency to shear along these joints in the case of any great lateral pressure. The piles also lessen the amount of concrete required. A small bucket was used in lowering concrete between the piles.

The Umpqua River bridge consists of nine 125-ft. fixed spans and one 348-ft. swing draw span, making a total of 1,473 ft. Only one of the fixed spans is south of the draw span. All are through spans of riveted truss members. The bottom of concrete in the pivot pier is 28½ ft. below ordinary low tide. Each opening of the draw is 150 ft. in the clear.

The Coos Bay bridge consists of nine 150-ft. and two 180-ft. through riveted spans, with one swing draw of 458 ft. The total length face to face of back walls is 2,208 ft. In addition, on the north end is a trestle approach of 30 bents and on the south end one of 168 bents, so that the total length of structures and approaches is 5,181 ft. The trestles have ballasted decks, all timber, but the decking is of cedar except as before described.

The swing span has a clear opening of 200 ft. each side of the pivot pier. The concrete in the latter extended 40 ft. below ordinary low tide, and the average cutoff of the piles was 2 ft. below ordinary low tide, being slightly below extreme low tide.

The concrete in the pivot pier of this (also the other drawbridges) was a 1:2:4 mixture up to low tide and of 1:2:6 above.

Besides the three main drawbridges described, other openings for the passage of miscellaneous traffic were provided. At several points on the wooden trestles crossing the different lakes and channels along the coast, steel plate girders of a span of 27 to 30 ft. were placed. These will permit barges containing engines and other equipment for logging operations to be passed. The pile bents supporting the ends of these girders were made correspondingly substantial, consisting of seven, nine and even eleven piles. In other places full draw spans were built, with hand-operated gearing. For these openings the logging companies are obligated to give the railroad company 24 hr. notice, so that men may be sent to open the draw.

The track was built with 7x8-in. by 9-ft. ties spaced 18 to standard rail length of 33 ft. New 75-lb. rails were used.

For all of the line north and east of the Umpqua River sawed fir ties were used, except for about 5 mi., where hewn fir ties were laid. For the part south of the Umpqua (about 30 mi.) Port Orford cedar ties were laid, with tie plates. The tie plates were used elsewhere on the road on curves of 2° and sharper.

On the westerly side of the summit, along the Siuslaw River above Mapleton, the location for long distances overlapped the highway. The railroad company was obliged to rebuild long sections of this highway in a new position, higher up. Altogether, 15 or 16 mi. were rebuilt, and in many places this work cost more than the railroad grade adjacent.

Methods and Organization

Work on through surveys started in 1910, and the first unit of construction was put under contract about Nov. 1, 1911. Inaccessibility of part of the country, together with the long rainy seasons, tended to delay progress. The portion put under operation, for commercial purposes as well as for construction, was gradually extended westward from Eugene. For that part south of the Umpqua, materials and supplies were brought from San Francisco to Coos Bay by sea, so that the closing was at the Umpqua bridge, and this was the last part of the road to be completed. The road was opened for its entire length in August, 1916. It is being operated as the Coos Bay branch of the Southern Pacific. Though no details are available, it is understood that the new railroad cost between $10,000,000 and $11,000,000.

The first contract, covering 25 mi. out from Eugene and including Tunnel No. 1, was executed by Twohy Brothers, of Portland, Ore. The remainder of the road (exclusive of bridges) was let to MacArthur, Perkes & Co., of New York City, and by them sublet to Porter Bros.-Grant Smith Co., who in turn sublet to many others.

The railroad company with its own organization and equipment did all the substructure work on bridges, also all bridge-deck work, trackwork and painting of bridges. The erection of the steel bridges was let to McCreary & Willard, except the Siuslaw bridge, which was erected by the company's own forces.

The engineering work was conducted by the Southern Pacific Co.'s regular organization. The chief engineer, William Hood, directed operations from San Francisco. The principal assistant engineer in charge was H. P. Hoey, who with W. R. Fontaine, assistant engineer, handled the work from Eugene. The three drawbridges and other bridges south of the Siuslaw were constructed under supervision of C. R. Broughton, with headquarters at North Bend. To these and their assistants the writer is indebted for data from which this article was prepared.

Adapting the Motor Truck to Its Work

First-Prize Motor-Truck Maintenance Article in the "Engineering News" Prize Contest

By Clarence B. Montgomery*

Most business men, turning from horses to motor trucks for delivery service, have depended on their judgment, biased more or less by the arguments of truck salesmen, for the solution of the variety of problems that arise—what kind, size and make of truck to buy, selection and payment of drivers, safe speeds and loads, housing, repairs, tires, costs, etc. This has resulted, during the past five years, in much expensive experimenting which may now be largely eliminated by drawing on variously accumulated experience. The writer has had charge of one of the largest fleets of trucks in Philadelphia for the past four years (that of the Union Paving Co.) and in addition has made a study of truck transportation in general, which perhaps justify an attempt to outline answers to the above problems of the uninitiated.

Selection of Truck

The respective fields of gasoline and electric trucks are so clearly defined that only passing mention need be made of the electric vehicle. The present cost of current and limitations of construction greatly restrict the use of electric trucks.

The size (capacity) of truck and type of body will be determined by the nature of the business. Where a large quantity of material is to be moved, the five-ton truck should be chosen. For delivering in smaller quantities or for distributing a load to several points a two-ton truck will be most economical. Light delivery cars occupy a separate field and will not be discussed here.

The body should be built as low as chassis construction will permit. All unnecessary weight should be eliminated. In dump bodies the power hoist is more economical than the hand-operated one.

Regarding the make of truck, the writer's company strongly condemns the "low-first-cost" trucks. A buyer is more than justified in paying a higher price to get a reliable, well-known, standard truck. The practice of buying trucks of several makes for comparative purposes is not favored. Select what you find to be the best truck and then standardize. The saving through interchangeability of parts is self-evident.

We have tried both wood and metal wheels and greatly prefer the latter. Tires give greater mileage over metal wheels, and wheel troubles are entirely eliminated. Tires are supplied of two types—demountable and pressure-applied. The pressure-applied type will be found more satisfactory and should be specified unless the truck is to work in some remote section, inaccessible to a service station.

The truck should be lettered with the owner's name, and if more than one truck is used, with a distinguishing number. This number should also appear prominently on the back end of the body, as it is often desirable to identify a vehicle when only the rear end is visible.

After the truck has been selected and equipped, we may turn our attention to the details of efficient operating. The frequently expressed opinion that teamsters make the best truck chauffeurs is not borne out by experience. The model truck driver is one who has served some time in a machine shop or garage, young, preferably married, with at least a fair schooling, temperate and honest. Drivers should be paid a definite weekly wage. In addition, they should receive a monthly bonus, based on the miles traveled and the amount of gasoline used. This bonus stimulates interest and coöperation in the driver, the most vital factor in profitable operation.

Overloading and overspeeding are two prominent pitfalls to be avoided. Abusing any machine is short-sighted economy. But speed governors are not to be generally recommended; a good driver does not need a governor, and a poor driver can ruin a car in spite of one.

Under suitable conditions hauling costs may be reduced 15% to 25% by pulling a trailer in back of the truck. This should not be attempted where grades over 10%, or bad road surfaces, are to be encountered. When using a trailer, the truck ought not to carry over 80% of its rated load, while the trailer may take an equal amount or slightly over.

Where three or more machines are kept, the owner should have his own garage, in which practically all repairs can be made. Here a supply of gasoline and oil may be kept as well as extra brake bands, two spare wheels (one front and one rear) and other minor parts. Three mechanics should keep 10 or 12 machines running. This will be possible by a system of continuous maintenance, a thorough overhauling yearly and discarding trucks when they are worn badly.

Cost Keeping

Accurate costs should be kept on every truck installation. The extent of detail will be determined by the number of trucks used and the relative cost of hauling compared to the entire cost of the material delivered. Most tire and truck companies distribute blank forms for recording daily costs. These are all similar in essentials and furnish an excellent basis for an accounting system.

The accompanying table shows a typical cost statement for a five-ton dump truck, giving each item entering into hauling costs and the necessary averages.

COST STATEMENT FOR FIVE-TON DUMP TRUCK

Fixed Charges	Per Day
Depreciation* ($4,100-$400 scrap value ÷ 1,200 days)	$0.46
Insurance (liability, fire and collision)	.58
License fee	.10
Truck foreman (supervising three trucks)	1.25
Driver	3.00
Total fixed charge per truck	$5.39

Variable Charges	Per Mile
Depreciation* ($4,100-$400 scrap value ÷ 50,000 mi.)	$0.0629
Gasoline @ 25c. (3 mi. per gal.)	.0833
Lubricating oil (64 mi. per gal.)	.0055
Tires (on guarantee basis)	.0386
Repairs	.0600
Total variable charge	$0.2503
Fixed charge (at 50 mi. per day)	.1078
Total cost per mile	$0.3581
Total cost per day	17.91
Total cost per ton-mile	.1433

* About 15% of the first cost depreciates with the passage of time, while about 85% is directly proportional to the miles run.

*1117 N. Edgewood St., West Philadelphia, Penn.

Five Water-Works Make Filter Alum—II

SYNOPSIS—Bauxite is treated with sulphuric acid by the cold process, producing alum cake, which is broken into lumps. The evolution of the process was outlined, and plants at Columbus, Ohio, Trenton, N. J., and Springfield, Mass., were described in "Engineering News" of Jan. 4, 1917. The Omaha plant, here described, differs from the others in some interesting details.

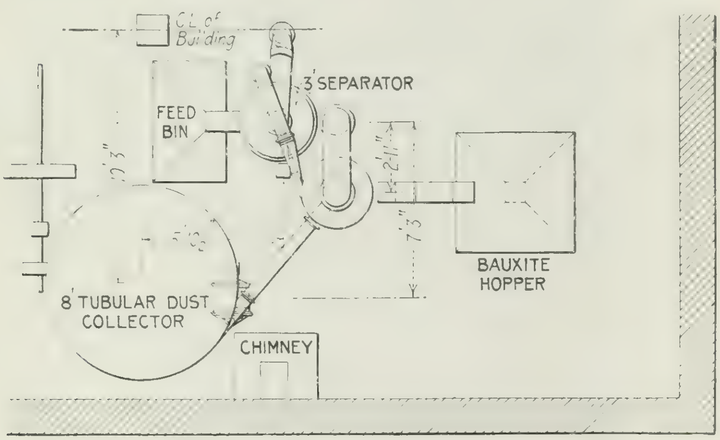
Omaha Installation Described

By George T. Prince*

The alum-making plant at the Florence station of the Metropolitan Water District of Omaha, Neb., has been in regular service since Aug. 19, 1916.

Bauxite, which is mined in Arkansas, is delivered at Florence, Neb., in box-cars. As it is received, about 95% will pass a screen of 1-in. mesh. It is unloaded from the cars by hand power and barrows and deposited upon the main floor, in the south end of the building at El. 80 (which elevation corresponds with that of the floor of the car), at a cost of 15c. per 2,000 lb. From the main floor the bauxite is shoveled through a 1x1-ft. floor grating of ¾x1½-in. iron bars, spaced 1 in. apart, into a 50-cu.ft. sheet-iron storage hopper. From this it is automatically fed into a mill (Figs. 4 and 5) that pulverizes it to a fineness resembling portland cement.

*Chief Engineer, Metropolitan Water District of the City of Omaha, Neb.



The pulverizer is placed on the floor of the basement, El. 70, directly below where the bauxite is stored. It is operated by a 25-hp. 3-phase 220-volt 60-cycle motor, running at 1,200 r.p.m., the mill running at 3,000 r.p.m. After passing the pulverizing mill, the bauxite is discharged into a cyclone collector and elevated by means of a bucket elevator into a steel storage bin having a capacity of about 60 cu.ft. The elevation of the top of this bauxite storage bin, which is hopper shaped, is 90.5 ft., and that of the bottom 84.5 ft.

From this storage bin the bauxite is drawn through a short vertical pipe into a weighing hopper (Fig. 6) having a capacity of 18.5 cu.ft., to which is adjusted a weighing apparatus. The flow of bauxite into the weighing hopper is regulated by a slide valve placed in the short vertical inlet pipe. The elevation of the top of the bauxite-weighing hopper is 84 ft. and that of the bottom 80.5 ft. From the weighing hopper the bauxite passes to the mixing pan, at a little lower elevation, its center being about 2.5 ft. to one side of the center of the weighing hopper.

Sulphuric acid is received at Florence in tank-cars containing approximately 55 tons, which weights are adjusted to conform with 60° Bé. acid, upon which adjusted weights payment is made. The tank-cars are unloaded by means of air pressure generated by a compressor driven by a 2-hp. motor. This compressor is placed on the main floor (El. 80) near the bauxite-weighing hopper and operates against a resistance of about 30 lb. per sq.in.

The acid is unloaded into a storage tank, 7 ft. 3 in. internal diameter and 35 ft. long, placed north of the north wing of the building and about

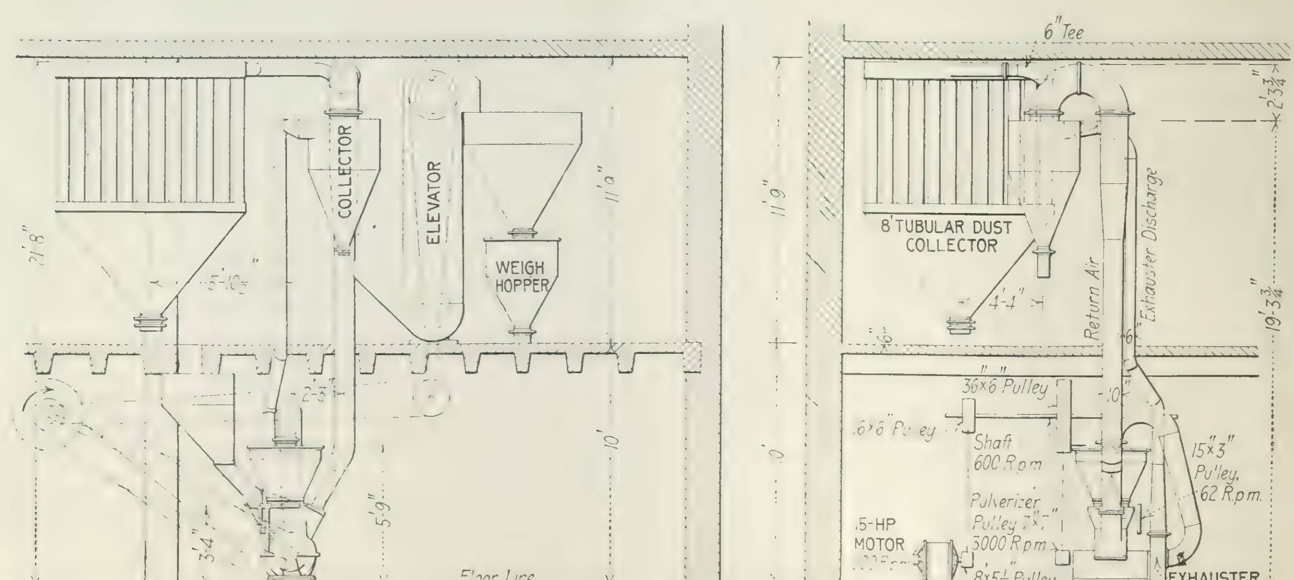


FIG. 4. DETAILS OF BAUXITE PULVERIZER, OMAHA ALUM PLANT

100 ft. from the air compressor. It is supported upon concrete pedestals about 3 ft. above the ground. Below this tank is a brick-lined pit in which is placed a cast-iron egg having a capacity of 20 cu.ft. and connected by suitable piping with the storage tanks.

The acid is drawn into the egg from the storage tank by gravity, and by means of air pressure is forced from the egg through 1½-in. lead pipe into a lead-lined wooden cooling tank that has a storage capacity of 115 cu.ft. and is located outside of and north of the east end of the main portion of the building, about 25 ft. from the mixing pan. The elevation of the bottom of the cooling

FIG. 5. BAUXITE PULVERIZING MILL, OMAHA ALUM PLANT

tank is 87 ft. The tank will store 13,000 lb. of 52° Bé. acid.

The acid purchased is approximately 60° Bé., whereas the gravity desired in the mixing process is 51° to 53°. If 60° Bé. acid were applied to the bauxite in the mixing pan, chemical action would at once ensue in the pan, causing the volume to increase fivefold and overflow the pan, as it would be impracticable to empty the pan quickly enough to prevent it; hence it is necessary to dilute the acid by the addition of water. This is effected by discharging a calculated amount of water into the cooling tank when empty, and then a calculated amount of the 60° acid is added. The combination of acid and water generates considerable heat which, if present in the acid when mixed with the bauxite, would be liable to cause the mixture to overflow the pan in a manner similar to that above noted, were 60° acid used. Hence the office of the cooling tank is to allow the diluted acid to become sufficiently cooled before use to avoid reaction taking place in the mixing pan.

During the month of September about 36 hr. were required in which to cool the acid sufficiently for use. The duration of the cooling period will doubtless change with the seasons.

If acid could be purchased of 52° gravity, this cooling process could be avoided; but to date it has not been possible to do this, as the shippers claim that 60° is the limit at which it is safe or practicable to use steel tanks as containers, for below this limit the acid attacks the steel. This is in contradiction to positive statements to the effect that "chamber-acid" of about 52° Bé. is being transported and stored in steel containers, without injurious results.

From the cooling tank the acid is drawn by gravity, at a temperature varying from 80 to 103° F., into an acid-weighing steel hopper having a capacity of 28 cu.ft., to which is adjusted a weighing apparatus. This hopper is placed above the mixing pan and at one side of its center, in a manner similar to the placing of the bauxite-weighing hopper.

Mixing the Acid and the Bauxite

Acid is drawn into the mixing pan from the weighing hopper, in which it has first been weighed, the weight being indicated by a scale beam placed against the east end of the room near the mixing pan. Two steel revolving arms in the pan are then set in motion by the action of a 5-hp. 3-phase 220-volt 60-cycle motor running at 600 r.p.m., the arms revolving at 20 r.p.m., and bauxite is added to the acid in the proportion of one part by weight of bauxite to two parts of acid, based upon 52° Bé. acid.

The mixing pan is made of steel plates and has a capacity of 28 cu.ft. The upper portion has vertical sides and an internal diameter of 6 ft. The lower portion is conical in shape and at its lower extremity is supplied with a steel plug fitting into a cast-iron seat. This plug is operated by a bent lever, by means of which the mixture of acid and bauxite may be held in the mixing pan or discharged into the crystallizing box below. The top of the mixing pan is at El. 80.

The mixing-pan process requires not more than 5 min., after which the mixture is allowed to flow to the crystallizing box. The mixing pan is then washed

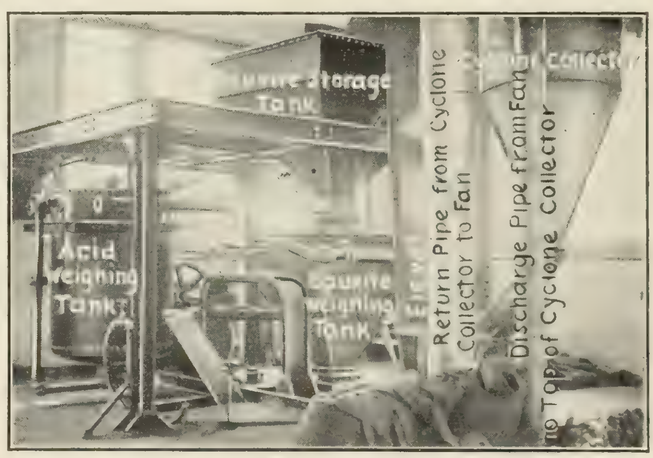


FIG. 6. MAIN FLOOR, OMAHA ALUM-MAKING PLANT

as clean as possible by a jet of water, the bottom opening is closed, and the pan is ready for another batch.

As above stated, the mixture is discharged into the crystallizing box, located in the basement at El. 70. This box is 13x25 ft. in plan, 3 ft. deep and is lined with concrete. In its west side, near the center, is built a wooden gate that is fitted with hinges and lock of the refrigerator-door type. The vertical joints at this door are first calked with jute before the crystallizing box is put into use.

About 20 min. after a batch has been discharged into the box, it begins to boil. The boiling continues for about 30 min., during which time the mass increases in bulk to nearly five times the space it occupied in the mixing pan, after which it gradually cools and hardens.

The cake is about 5 in. thick and when hard can be easily lifted from the floor of the pit by means of a bar and then broken into small lumps for use. It is afterward loaded into a wheelbarrow and removed to an adjoining storage room. To remove 9,000 lb. of the cake requires one man 8 hr. This work is divided between the day and the night man.

Cost of Finished Product

The plant is a success and produces an alum which is more basic than that formerly purchased and which is therefore more efficient for use in water purification.

Bauxite is delivered at Florence at $10.72 per 2,000 lb. and acid (60° Bé.) at $28. To make one ton of alum, composed of two parts of acid by weight to one of bauxite, would cost for materials $18.50. The equipment has cost $7,013, made up as follows:

Storage tank in place	$800
Acid-egg, including vault	100
Piping and valves	167
Cooling tank and inclosure	574
Steel hoppers, tanks, mixing pan, 5-hp. motor elevator and framing	1,836
Pulverizer	1,250
25-hp. motor	307
Scales	125
Sundry materials, including shafting and belting, also air compressor	400
Transmission transformers, wiring and labor	600
Concrete lining of crystallizing pit, including door	200
Labor, not included above	654
Total	$7,013

It will be noticed that, with the exception of the lining of the crystallizing pit, no item of building is included. The building contains apparatus for the preparation and application of lime and alum solutions to the water-supply, as well as for the chemical, bacteriological and physical laboratories.

Capital charges and minor repairs may be considered about as follows:

4½% interest on $7,013	$315.58
5% depreciation (15 yr., 4%)	350.65
Minor repairs	100.00
Per year	$766.23

Under the existing rate of consumption at Florence this would amount to $1 per ton of alum, which added to $18.94 makes $19.94 per ton of alum as the total probable cost at present prices, to which should be added cost of electric energy generated at the Florence station, estimated as 12c. per ton (1c. per kw.-hr.) making a total estimated cost of $20.06 per ton.

No charge is made for labor, as the usual force of two men, heretofore employed in mixing and applying the alum and lime, also attend to the pulverizing of the bauxite and making and removing the alum cake. The chemist supervises the proportioning of the bauxite and acid and has general charge of the purifying works. It takes one man 2¼ hr. to pulverize 3,000 lb. of bauxite. During this time he also looks after other work. It requires from 45 to 60 min. for two men to mix 9,000 lb. of alum and discharge it into the crystallizing pit.

After each batch of 9,000 lb. it is necessary for the attendant to spend about 30 min. chipping off hardened alum from the upper portion of the mixing pan. A slight reaction takes place at the surface of the mixture during the process of mixing, causing a hard scale to form. The lower portion of the pan can be kept free from this scale by a water jet after each batch.

So far as the pulverizing and mixing are concerned, the plant could turn out six tons of alum per 10 hr. To do this would require increased facilities for cooling the acid and disposing of the cake; hence the present nominal capacity may be considered as three tons of alum per 12 hr. The average amount of alum required at Florence is 1,000 lb. per 24 hr., distributed through the year. The maximum requirement is about 6,500 lb. At present we are making about 1,300 lb. per 24 hr. By expending $500 for enlarged facilities for cooling and suitable apparatus for breaking up the thicker cake, the plant could easily turn out six tons of alum per 24 hr., though to do so would require additional labor and increase the cost about $1 per ton. A coil of lead pipe in the cooling tank through which cold water would flow would produce the desired result at less cost than duplicating the tank.

It will be noticed that the life of the plant has been assumed as 15 yr. Perhaps this may be high. If it be taken at 10 yr., the fixed charges would be $1.30 per ton, or an increase of 30c. If the life be further shortened to 5 yr., the fixed charges would be $2.23 per ton, or $1.25 more per ton than at 15-yr. life.

Swimming Pool on Top Floor of Old Club Building

Building a large swimming pool (with a load of about 400 tons of water) on top of an old building was an interesting part of the enlargement of the eight-story Union League Club Building in Chicago. This work was described by Frank E. Brown in a paper read recently before the Western Society of Engineers. The building is about 100x149 ft. A swimming pool was desired, but there was no available space in the basement; therefore, three stories were added to the rear part of the building (100x49 ft.) to accommodate the pool and gymnasium.

The swimming pool is 30x60 ft., with a depth of 4 to 8½ ft. The old cast-iron columns could not carry much additional load, and replacing them with new steel columns was out of the question, especially as the old foundations were inadequate. They were strengthened, however, to carry the ninth floor. The tenth floor (swimming pool) and eleventh floor are carried independently by new steel columns located so as to clear the old foundations and not obstruct important rooms. This arrangement involved difficult work in cutting and reframing the structural work in the building.

The sides of the pool are formed by plate-girders about 11 ft. deep, and the bottom has 18-in. I-beams spaced 13 to 24 in. c. to c., with a ⅜-in. deck plate riveted to their top flanges and to continuous angles on the sides of the girders. Steel trusses in the tenth story support the upper walls, some of these trusses being cantilevered 7 to 10 ft. from the new columns to the walls.

The waterproofing of the swimming pool was a special problem. The original intention was to make the steel tank water-tight by calking and riveting, and to line this with membrane waterproofing, concrete and tile. Instead, a lead lining was used. The rivet heads on the girders were flattened to ½ in., and a 1½-in. coat of cement was put on with the cement gun. On this was applied the sheet lead, 4 lb. per sq.ft. (about $\frac{1}{16}$ in. thick), tacked at the joints to wood strips set in the cement. The joints were then soldered.

On the lead was placed membrane waterproofing, then 4-in. cement (with the cement gun) and finally the lining of ¼-in. tile set in cement mortar. The bottom was treated in the same way, but with less concrete, the total

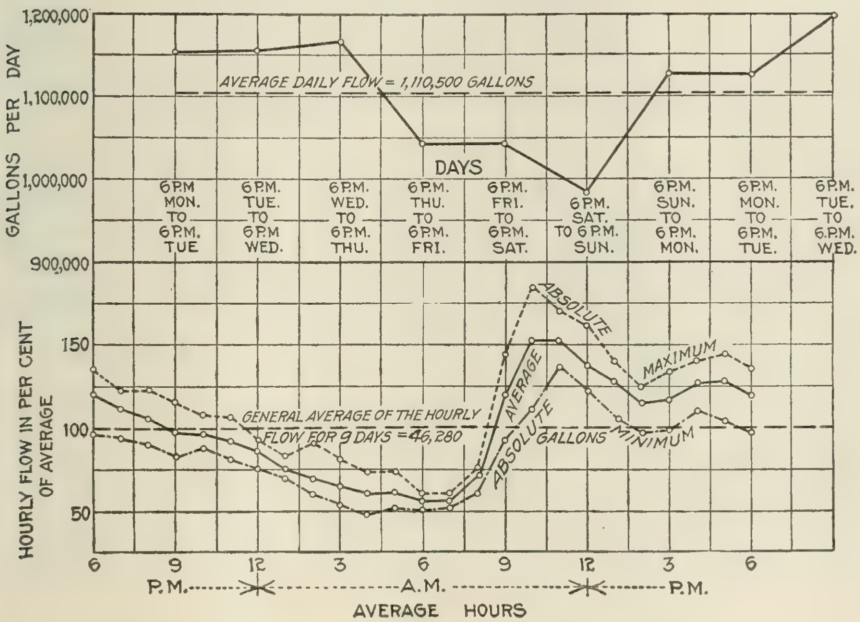
thickness of the lining being 7 in. for the sides and 4 in. for the bottom.

The water, after being treated with alum as a coagulant, passes through a quartz filter, a heater and then a violet-ray machine. The water is kept in continuous circulation and at uniform temperature. The tank is to be emptied and cleaned every two months.

Sewage Flow Measurements, Austin, Texas

By Julian Montgomery*

In 1914 the Texas legislature passed a stream-pollution bill that makes it necessary for the City of Austin and the State of Texas to treat properly the raw sewage coming from their mains before it is emptied into the Colorado River. As both mains empty into a common outfall, the cost of a system for the disposal of the combined sewage should be borne jointly by the state and the city. In order to arrive at a rational basis for prorating this cost and to obtain complete total volume-of-flow data for the purpose of design, measurements of the flow of the sewage were made by rectangular contracted weirs on both the state and the combined mains.



SEWER GAGINGS AT AUSTIN, TEXAS

Not knowing the personnel of the legislative committee that will pass on the merits of the proposition to be submitted by the City of Austin, in which the State of Texas will be asked to pay a certain portion of the cost of the disposal plant, very elaborate data were collected for a rather lengthy period. It was decided to use Francis' formula in calculating the quantities of sewage. For an accurate application of the formula it was considered essential to observe every precaution, as did Francis in deriving his equations.

Hook gages were used to get the head on the weirs. Readings were taken every 15 min., day and night, for nine days. This gave a week cycle with an overlap of two days to care for any possible mishap. The men taking readings were made as comfortable as possible. Both lanterns and flash lights were used to take readings at night. In calculating the quantities of flow the average of the head raised to the 3/2 power for four 15-min. intervals was obtained, and this average $H^{\frac{3}{2}}$ was used in the formula $Q = 3.33(b - \frac{2}{10}H)H^{\frac{3}{2}}$ to obtain the quantity per hour.

It should be mentioned that the results were arrived at probably with more care and exactness than is usually thought necessary to observe for such measurements. The precautions imposed prior to and during the time at which readings were taken reduced to a minimum the percentage of error in the application of Francis' formula. Accepting the reliability of the formula, the small increment of time between readings of the hook gage gave an abundance of data that is an accurate index to the hourly, and consequently the daily, flow.

The accompanying curves were plotted from the combined sewage data. They may serve to give ideas of the variations of the hourly and daily flows at other cities. Of especial interest are the percentages of variation of the maximum and minimum hourly flows from the average hourly flow. It is seen that the variation of both the maximum and minimum from the average is about the same, being some 53%. A study of the average hourly-flow diagram shows that for about half of the day the flow is below the average, and above the average from 9 a.m. to 9 p.m. The rate of change is roughly a constant and always negative from 9 p.m. to 7 a.m., but the rate change for the period during which the flow is above the average is erratic. From 11 a.m. to 2 p.m. the rate of change is negative, from 2 p.m. to 5 p.m. the rate of change is positive, and from 5 p.m. to 9 a.m. the rate of change is negative, being positive again from 7 a.m. to 10 a.m. and practically zero from 10 a.m. to 11 a.m. The absolute-maximum and the absolute-minimum curves shown were plotted from the maximum and minimum hourly flows that occurred for each particular hour of the day during the nine days that readings were taken.

The measurements were made from the office of M. C. Welborn, city engineer. The writer had direct charge both of the field and office work. Engineering students from the University of Texas were employed to read the hook gages and aid in the numerous calculations.

*Assistant City Engineer, Austin, Tex.

Electricity for House Heating has been studied for several years by the Seattle Municipal Lighting Department, and enough data have been accumulated to afford some general conclusions. Eight different homes were equipped in various ways. Need of heat storage was shown (for the heating peaks came at 6:30 to 8 a.m. and 5 to 10 p.m.), until the heating load outgrows the lighting. But about ten times as much current is demanded for heating as for lighting a dwelling, so that when one house in ten is electrically heated the load-curve valleys will be filled and no more off-peak energy will be available. Where electric house heating is to be undertaken on any considerable scale, very cheap current is required. For the Seattle climate, electric house heating is 25 to 50% more expensive than coal—with current at 1c. per kw.-hr., coal of 1,000 B.t.u. per lb. at $6 per ton, and a 40% furnace efficiency.

Adding 11 Ft. to Top of Trap-Rock Dam at Bridgeport

By Charles A. Hirschberg*

SYNOPSIS—Increasing water-supply needs required enlargement of reservoir at Bridgeport, Conn. Mass-concrete dam 49 ft. high raised to 60 ft. and lengthened from 835 ft. to 1090 ft. by adding mass concrete on top and strengthening downstream face by buttresses and earth-fill. Details of construction, particularly the methods of bonding the old concrete to the new.

The growth of the City of Bridgeport, Conn., both commercially and in point of population, has been very marked during the past five years. In anticipation of a continuance of this growth the Bridgeport Hydraulic Co., which supplies the city with its water, has had under way various plans for an increased water-supply. One of the most important of these plans has been the Trap Falls Reservoir enlargement.

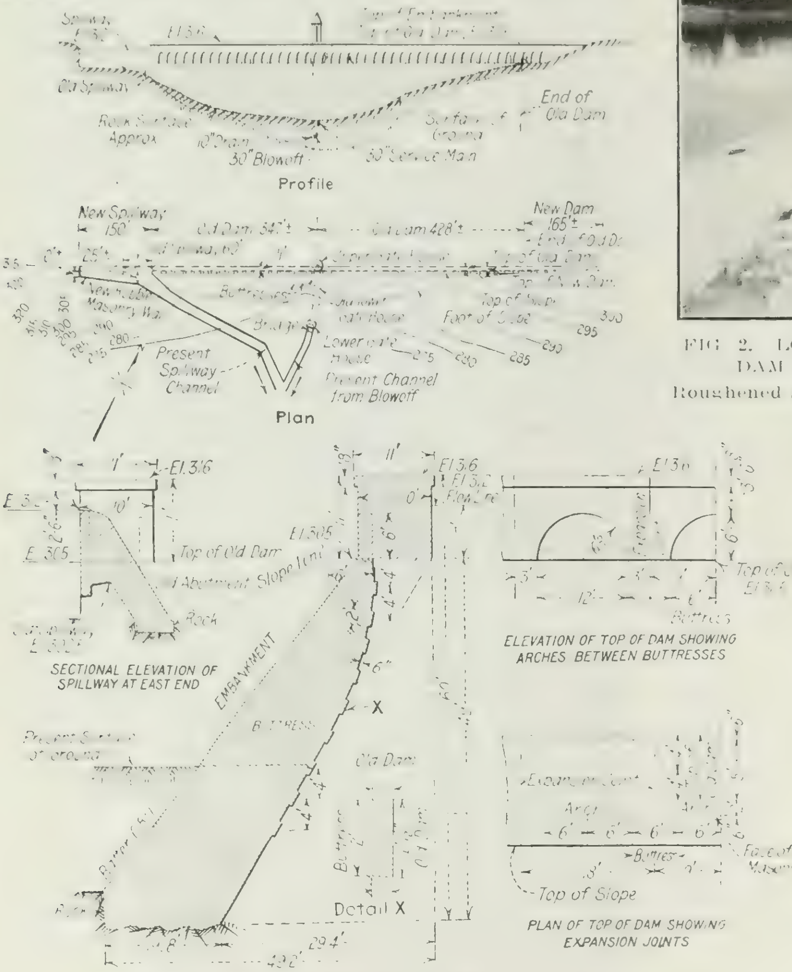


FIG. 1. DETAILS OF ENLARGEMENT OF TRAP FALLS DAM AT BRIDGEPORT, CONN.

The Trap Falls Reservoir lies in a natural basin approximately 8 mi. above the City of Bridgeport and before reconstruction covered an area of about 240 acres of ground, closed at its outlet by a concrete dam of mass structure built 11 years ago. The water is piped to the reservoir through 3 mi. of 30-in. mains from the Far Mills River, which has a drainage area of about 7 sq.mi. and through 4 mi. of 36-in. pipe from Means Brook, with a drainage area of 8 sq.mi. The capacity of the reservoir before reconstruction was 1400 million gallons of water—over 50% below the capacity for supply of the drainage area. The problem, therefore, involved the provision for larger storage capacity. To avoid extended shutdown of the water-supply from this reservoir, the Bridgeport Hydraulic Co.'s engineers decided upon the reconstruction of the old dam, in accordance with the plan shown in Fig. 1. It is interesting to mention that work progressed without in any way interfering with the water-supply except for a period of one week during the placing of the concrete buttresses in the vicinity of the service main. A comparison of the old and new dam structures (Fig. 2) shows an increase in height of 11 ft. and an increased length of 225 ft. The acreage of the reservoir is enlarged to 300 acres, and it will have a capacity for 2200 million gallons of water. The changes in the dimensions of the dam are given in the following table:

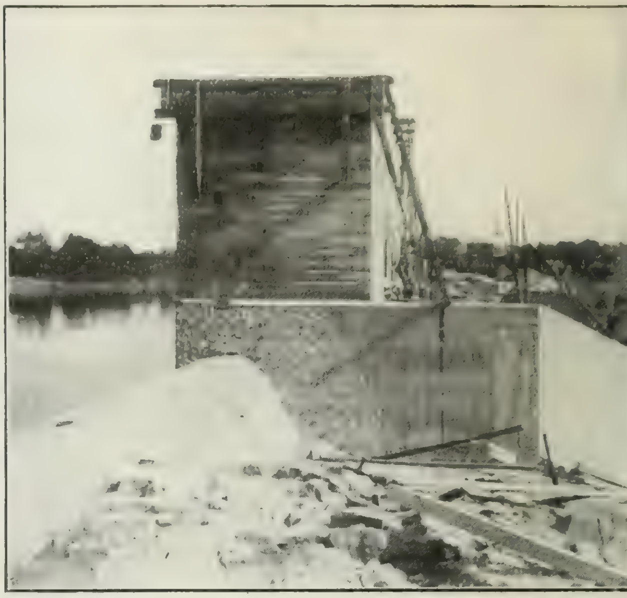


FIG. 2. LOOKING TOWARD ENLARGED SECTION MAIN DAM WITH OLD SPILLWAY IN FOREGROUND

Roughened surface indicates where new spillway section goes

	Length Exclusive of Speedway, Ft.	Length of Spillway, Ft.	Total Length, Ft.	Maximum Height, Ft	Width at Bottom, Ft.	Width at Top, Ft.
Old..	775	60	835	49	29.4	8
New	940	150	1,090	60	49.2*	10

* Over buttress

*Ingersoll-Rand Co., 11 Broadway, New York City.

The old structure was of mass concrete, and no provision whatever had been made for expansion; as a result the dam developed cracks with slight leaks. In the reconstruction, expansion has been provided for in a unique manner. Blocks of concrete 11 ft. high, 18 ft. long and 10 ft. wide were placed alternately 18 ft. apart on the top of the old dam and permitted to harden thoroughly before the intermediate blocks were poured. These blocks were joined to the old structure by means of a channel or keyway 18 in. wide and 4 in. deep, cut along the full length of the top of the old dam.

The increase in height made it desirable to brace the structure to take care of increased stresses. For this purpose 46 buttresses, as shown in Figs. 1 and 7, were provided. They are 6 ft. wide, placed on 18-ft. centers and connected at the top by fascia arches, which also support the overhang of the concrete blocks placed at the top of the dam. The buttresses are filled in between with earth.

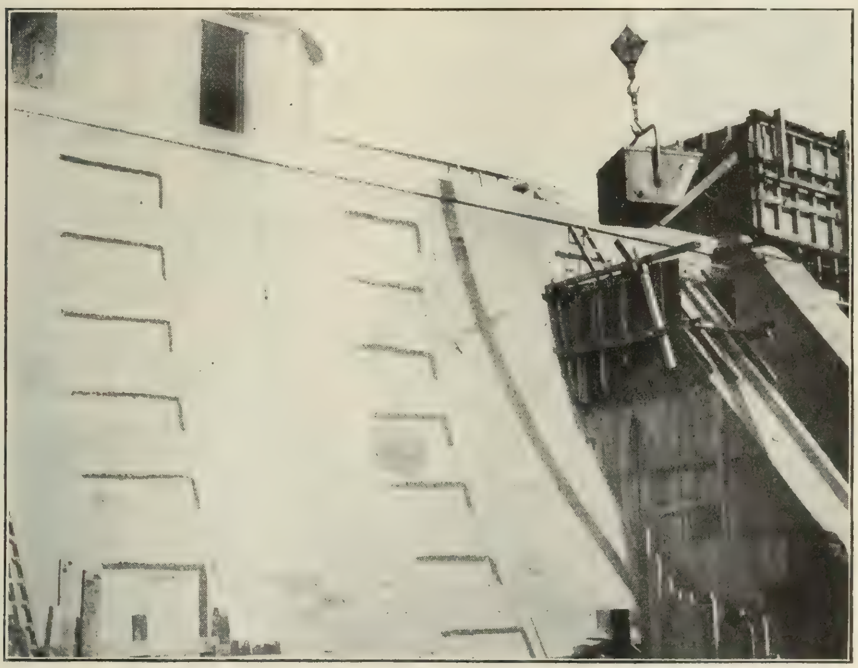


FIG. 3. MORTISES IN FACE TO TAKE NEW BUTTRESSES

The greatest problem presented in this work was perhaps that of tying the new additions to the old structure. In Figs. 1 and 3 is shown the method adopted to key the buttresses. In order that these buttresses could take the thrust, mortise and tenon joints 6 ft. long by 2 ft. wide and 6 in. deep were made, 4 ft. 6 in. apart on a vertical plane in the face of the dam.

Methods of Cutting Mortises and Channel

The channel in the top of the dam and the mortises in the face were cut by drilling, broaching and picking, employing three "Jackhamer" drills and three "Little David" pneumatic picks. Holes were drilled with a 1½-in crossbit, approximately 1 in. apart both along and across the channel, to a depth of 4 in. This was followed by the pneumatic picks employing a special broaching tool, as shown in Fig. 4, along the outside edge of the channel, breaking down the intervening concrete to form a continuous groove. An ordinary pointed pick was then inserted in the pneumatic hammer and the drilled concrete chipped out.

In making the mortises for the buttresses, holes 6 in. deep were drilled with Jackhamers, as closely together as they could be placed, with a 1½-in. crossbit. The men operating these drills worked from suspended platforms, and the drills were supported in special hangers suspended from 2½-in. air pipes strung along the face of the dam. The concrete between holes along the edge of the intended mortise was then broached by the flat tool already referred to, and the remaining concrete picked out by the pointed pick operated by a pneumatic hammer. One man and a Jackhamer drilled and broached one complete mortise in 4½ hr., and one man with a pneumatic pick averaged one mortise completely chipped out in a similar length of time. These tools were also used for drilling concrete form anchor-bolt holes to a depth of 6 in. All steel was sharpened by hand, a total of 60 pieces of 12-in. lengths being required for the job, which comprised 213 mortises, 775 ft. of channel and more than 500 six-inch anchor-bolt holes. To obtain a suitable rock footing for the buttresses, the overburden at the base of the dam was removed with pick and shovel. Where the natural contour of the rock did not provide a satisfactory footing, holes were drilled and blasted, the object being to obtain a saw-toothed surface.

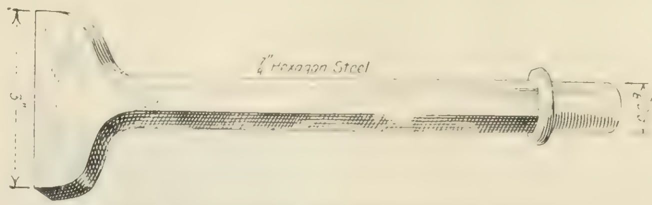


FIG. 4. DETAIL OF BROACHING TOOL

Collapsible wooden forms were used for all concreting. Forms for the buttresses were shifted by stages toward the top, each pouring of concrete being permitted to set sufficiently before shifting the form. For keying each successive pouring of concrete, large pieces of rock were embedded in the concrete at the finish of each pouring.

FIG. 5. LOOKING OVER TRAP FALLS DAM DURING RECONSTRUCTION

Each partially set batch of concrete was thoroughly wetted down before the next pouring.

For shifting the concrete forms, handling the rock and overburden at the base of each buttress, and also for dirt filling between buttresses, a Lidgerwood traveling derrick was employed. The object of the dirt filling is not only to lend additional support to the concrete structure, but to eliminate opportunity for freezing and spalling during cold weather. The concrete plant comprised two 1-cu.yd. steam-engine driven Ransome concrete mixers located at the western end of the work. All materials were supplied to the mixer at the top by means of a boom derrick and clam-shell bucket. A unique feature of this portion of the installation is the manner in which the concrete was conveyed to the Lidgerwood cableway that served the dam. Fig. 5 is a general view overlooking the dam, taken from one of the cableway towers. A small steam-operated winch carrying an endless cable hauled a flat-car back and forth on a track placed at right angles with the cableway and parallel with the concrete-mixer dumping chutes. Hand-operated square dumping buckets were placed on this flat-car and run in under the chutes. One was filled and returned to the dam, where the cableway traveler picked it up and conveyed it to the point of deposit. In the meantime the other bucket was being filled (Fig. 6).

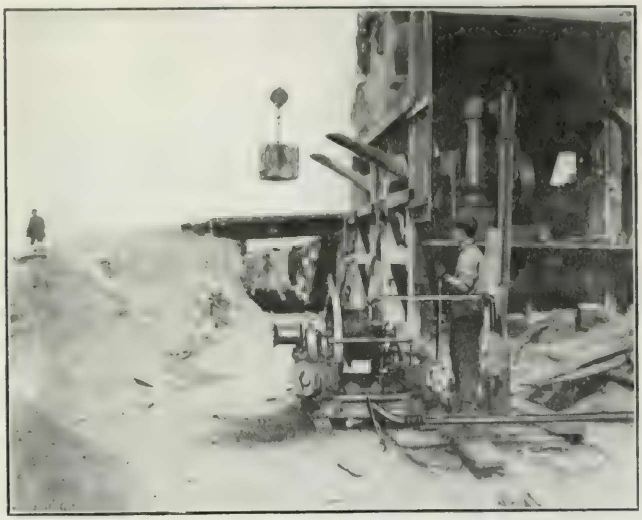


FIG. 6. AT BASE OF CONCRETE MIXER

The concrete mixture was 1 : 2½ : 4½ for the top and 1 : 3 : 5 for the buttresses. About 8,000 cu.yd. of concrete was required. All materials for the concrete were hauled in by four 5-ton Locomobile trucks. Two of these trucks were equipped with power self-dumping bodies, the other two with plain hinged bodies, which were dumped by means of the derrick serving the mixers.

The company operates its own trap-rock quarry, situated about 2 mi. from the dam. The trap rock, which is of a particularly hard, stubborn nature, full of cleavages and therefore presenting unusually difficult drilling, is excavated by means of three D21 Sergeant steam drills. The average drill hole footage is low and gives a fairly good idea of the character of the rock—12 ft. per day per drill operated by two men.

A No. 5 McCully gyratory crusher installed at the quarry crushed all the rock, the straight run-of-crusher material larger than ⅜ in. being used in the mixers; none of it, however, ran larger than 2½ in. Sand was hauled to the dam a distance of approximately 1½ mi. For dumping the concrete in the buttress forms a portable inclined V-chute was employed, as shown in Fig. 1.

All machinery was steam operated, excepting the hammer drills at the dam, a 125-hp. boiler supplying all the necessary steam. All the machinery had seen service on numerous undertakings of the company, some of it having been purchased as long ago as five years before.

Work was started Aug. 1 and completed about the first of this year, an average of 100 men per day being employed. Considerable preparatory work had to be done before actual work began at the dam. It was necessary to build new and higher roads to replace those which would become inundated by the enlarged reservoir, to say nothing of the grading of certain portions of the reservoir banks and the clearing of the new land.

FIG. 7. NEW FACE OF RAISED TRAP FALLS DAM FOR BRIDGEPORT HYDRAULIC CO.

The work was done by the Bridgeport Hydraulic Co., under the supervision of its own engineers. S. P. Senior, Vice-President of the company, is Chief Engineer; W. C. Pollitt is Engineer-in-Charge of the work; and A. B. Hill, Consulting Engineer.

A Government Railway in the United States is a 23½-mi. line from Yuma, Ariz., to the Mexican boundary. The United States Reclamation Service has built a levee to protect land in the Yuma Valley from the annual overflow of the Colorado River. This was first protected against erosion by spur dikes and brush mats, but rock revetment became necessary and this could be placed economically only by a railway upon the levee. As local railway and other interests would not take the matter up, in view of the improbability of such a line being a financial success, the line was built by the Reclamation Service in 1914. Over 300,000 tons of rock have been handled and placed. Regular passenger service is maintained by a McKeen gasoline motor-car having seats for 70 passengers.

Rebuilding with Permanent Surface Old Macadam Roadways

Second-Prize Road-Building Article in the "Engineering News" Prize Contest

By Theron M. Ripley*

The writer assumes that a "permanent surface" which can be built and maintained indefinitely is one the minimum cost of which is its reconstruction cost plus the annual maintenance cost capitalized at the rate for which the builder can borrow, say 4%.

Heavy traffic within or adjacent to a city of 30,000 population would not be heavy traffic for a similar location to a city of 300,000 or 3,000,000 population. If "heavy" refers to a dense traffic of light vehicles, the problem is different from a traffic, of any density, consisting of heavy vehicles. In the past macadam roads have been constructed where, today, traffic of both varieties obtains.

For roads of dense light-vehicle traffic—namely, ordinary farm and automobile traffic—where a foundation course of telford yet remains, a permanent top can be constructed of either bituminous macadam or concrete, depending upon the cost of construction and maintenance. Frequently this latter cost is indeterminate except within relatively wide limits. The estimated cost of reconstruction, for purposes of comparison in the determination of type, can readily be obtained.

For the great majority of roads, outside of business districts, where funds are limited, we are confined to three types—cement-concrete, mixed-bituminous and penetration-bituminous tops. This limit is due to the fact that the excess first cost of block pavements in all but favored localities is greater than the first cost of any one of the three types mentioned plus their maintenance cost, capitalized. This limit, moreover, brings us into the cheaper types and, consequently, more easily within the limit of the "money available."

For residential streets in cities and villages the mixed-bituminous tops should be given careful consideration for reasons of color, noise and slipperiness. For a suburban and rural traffic that has developed beyond the waterbound-macadam stage, but is not and may never be a mill, mining or heavy commercial traffic we are practically confined to two types—concrete and penetration bituminous.

Save the Telford Foundation

The premises of this article presuppose "often on a solid telford foundation." If it is not solid, the problem receives a new equation; namely, is it solid enough for concrete, if not for bituminous macadam? The limits of this paper will not permit discussing this equation; we must assume that the foundation is solid.

In no instance should the old telford base be removed unless conditions aside from those of actual resurfacing require it. Use the old top for reshaping the telford or repairing shoulders. The old foundation should be subdrained with tile or blind drains or both, keeping the tile at least 18 in. deep and carefully backfilling the trenches with broken stone, using the blind drains as feeders to the tile. The lateral ditches in clay and heavy loam should be at least 2 ft. below the crown of the road.

It must be constantly borne in mind that *no* surface will withstand heaving by frost action or settling under traffic into a quagmire. If there is a subsurface flow across the road, particularly in heavy soils, a tile drain in the shoulder or ditch is a necessity. Use 6-in. vitrified tile with joints wrapped in burlap and have outlets every 250 ft., if possible. The "lay of the land" must determine the details. Never forget the lateral, or cross, drains in any soil containing clay.

Comparative Costs

For comparison of cost, to determine the type, three roads built under the writer's supervision will be used. The cement-concrete resurfacing (built in 1914) was tile drained and cost \$1.216 per sq.yd., including the repair of shoulders and ditches. Two bituminous-penetration jobs (built in 1914 and 1916), similarly subdrained, reditched, etc., cost 71.7c. per sq.yd. The pavement in each instance is 14 ft. wide. These costs give \$1.216 — \$0.717 = 49.9c. per sq.yd. in favor of the bituminous penetration, which multiplied by 4% gives 1.996c., which can be used for maintenance.

The maintenance cost of the cement concrete has been 1.166c. per sq.yd.; that of the bituminous road (no costs on 1916 roads) has been 5.266c. per sq.yd. Therefore, 5.266 — 1.166 = 4.1c., and 4.1 — 1.996 = 2.104c. in favor of the concrete road. This 2.104c. capitalized at 4% = 52.6c. per sq.yd., equal to \$4,320.04 per mi. of 14-ft. pavement, which of course represents the allowable additional investment in a concrete over a bituminous penetration pavement. The pavement in each of the above cases was built upon the old road foundation.

"There is generally need for widening the old roadway." Place more telford on one or both sides of the old foundation, rolling the entire width of both so as to have a uniform bearing for the top. Shape the foundation practically the same as the finished top for bituminous macadam (crown 3/8 in. per foot of half width), and make it level for concrete. Do this by building up on the sides. Do not remove the old foundation, if possible to avoid it.

Material excavated can be used for widening and raising the shoulders or widening a near-by fill. A 16-ft. paved roadway with 7-ft. shoulders of good bearing material will care for an immense amount of light traffic, but with heavy truck traffic a three-track surface of 22 or 24 ft. is required.

Whether 100 or 1,000 vehicles per day use a properly constructed bituminous or concrete top will make little difference in its maintenance so long as they do not break its surface, but one good hard winter with its accompanying spring break-up will make an undrained road, no matter how hard its top, look like a badly ploughed field.

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*Division Engineer, New York State Highway Department, Watertown, N. Y.

The Miami Valley Flood-Protection Work

II—Why Retarding Basins Were Adopted

Development of Miami Protection Plans; Retarding Basins the Only Solution; How Basin and Channel Work was Balanced; A Statement of the Factors That Favor Retarding Basins in the Miami Valley

The nine judges of the Miami Conservancy Court declared unanimously, only a few weeks ago, that retarding basins are the best and only practicable method of flood protection for the Miami Valley. Their finding was a restatement of what the engineers had discovered nearly two years before.

The early investigation made by the Morgan Engineering Co. for the Dayton Flood Protection Committee, and later for a similar Miami Valley committee representing all parts of the river basin, was begun frankly on a channel-improvement basis. For the first month or two the problem assigned was primarily to find a means of protecting Dayton and incidentally to learn whether the problem was a local one or must concern the entire valley. Very soon the whole valley was made the primary objective, as it became recognized that success could come only through coöperation.

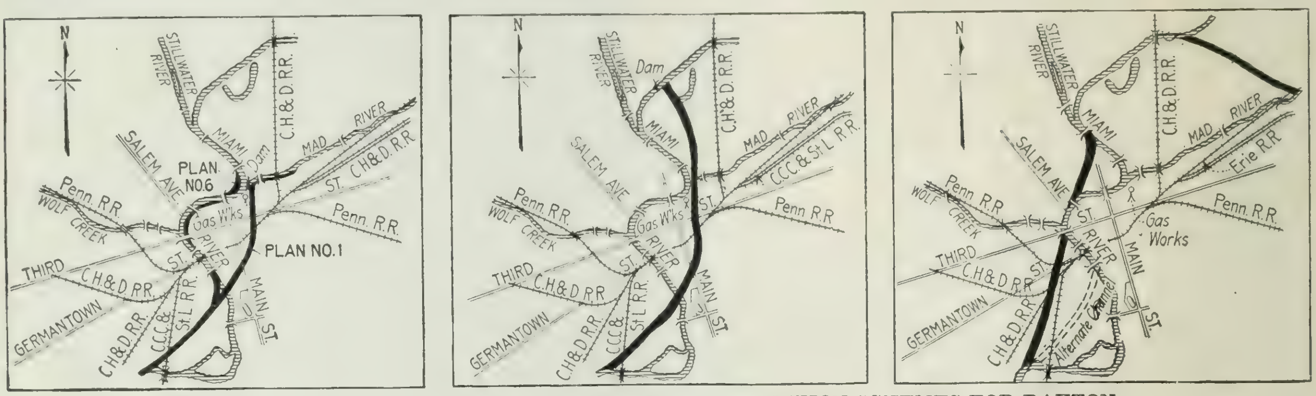


FIG. 1. SKETCHES OF SOME EARLY FLOOD PROTECTION SCHEMES FOR DAYTON

One-channel improvement and three diversion plans: Plan 1, at left, diversion of the Mad River by a dam at its mouth through a channel along the Miami and Erie Canal, in conjunction with two storage reservoirs on the Stillwater; Plan 2, in middle, has the same reservoirs, but a joint diversion of both Miami and Mad Rivers along the canal location; Plan 3, at right, diversion of Mad River into the Miami, with a west-side cutoff to carry the three rivers; Plan 6, at left, channel improvement through the main part of the city

Construction of bypasses or cutoffs, widening and deepening of the river, levee raising, diversion of one or another branch of the river into a neighboring drainage area—these and all other possible schemes for dealing with Miami floods were studied. Definite cost estimates were made for most of them. The sketch plans grouped in Fig. 1 outline several of the preliminary schemes for the Dayton protection. Similar ones, equally radical, were devised for a few other parts of the valley.

Full Trial of Bypass Projects

Two among the projected methods for protecting the City of Dayton are characteristic: The first had as its main feature a huge reinforced-concrete culvert through the city along the line of the old Miami & Erie Canal, on the east bank; the second involved open bypasses on the west bank. It was found possible to put the east-side box culvert through the city at a cost of perhaps $15,000,000. The city would be cut apart by a 10-ft. wall. Auxiliary levees above and below the city would be required to confine the waters. The railway entrance to the city would be blocked, and the city would be confined within ramparts, throttling its development. The west-side bypass channel required excavation and the placing of concrete 30 ft. below groundwater for miles, through a densely settled district, and at best proportions it entailed water velocities up to 20 ft. per sec.

These two cases picture the general unpromising aspect of all the diversion schemes. Channel improvement showed up little better.

The five concrete bridges crossing the river within the city were a first obstacle. It would have cost $1,000,000 to raise them for a higher flood level, and a large additional amount to carry the piers down lower, for channel deepening. Probably tearing out the old bridges and building new ones would have been the best course. However, this was the least of the difficulties encountered.

By widening the river through high-priced property, as much as possible; deepening its channel 10 ft.; paving the bottom to withstand high velocities; and, in some of the variations, raising the existing levees by amounts of 3 to 5 ft., the 1913 flood flow could be carried through the city. How the water could be cared for at the sloping drop (or dam) required at the upper end of the city to deliver the flow safely to the improved channel remained a problem.

At the most moderate estimate the cost of the whole work would run up to $16,000,000 or $20,000,000. This would protect Dayton alone. A large annual maintenance expense had to be faced in addition. A further complication of the case appeared at this time. Computations of the amount of water stored in the overflow portions of the valley during the 1913 flood showed that this storage was of enormous amount. With full-capacity channels, giving a more rapid flood wave by eliminating the valley storage, the greatest flow at Dayton would be raised from 250,000 to 300,000 sec.-ft., and at Hamilton from 350,000

to 500,000 sec.-ft. The increased figures made the problem virtually impossible.

From the first, attention had been given simultaneously to all possible means of protection. The survey parties reconnoitered for reservoir basins and dam sites, while they were taking flood levels, topography, river slopes and geological memoranda. Elaborate studies of what reservoir control has accomplished in other parts of the world were started in the summer of 1913. Control by "dry reservoirs"—retarding basins—was suggested at the same time. Data were being accumulated that placed increasing emphasis on storage or detention possibilities.

Investigation of Basins for Flood Reduction

The ultimate result of the work, by the end of 1913, was that local protection—by channel improvement, by bypasses, by levees—had demonstrated its impracticability. Basin-storage projects were now outlined and studied, though at first with not much faith. Very shortly the planning was centered on dry basins, as giving obviously the maximum flood reduction. Further steps in the progress of thought soon introduced the idea of minimum-time detention—that is, making the permanent outlets of the basins just as large as the channels below could be adapted to. The three advantages secured by quick emptying of the basins were (1) that the farm lands in the basins would remain wet the shortest time; (2) that the basins would quickly be ready for new service in the improbable case of a second storm coming soon after; and (3) that during the early part of the storm the capacity of the basin was being held empty and available for storing the crest of the flood.

The unpromising flat valley of the Miami and its tributaries was found to possess excellent basin locations, with dam sites permitting the construction of moderate-cost dams and affording enormous volumes of storage. These sites were studied in detail. Many reservoirs were laid out, their influence on flood flow was studied, and various combinations were made.

It was then found that the available reservoir storage was large enough, and sufficiently well distributed, to enable complete flood control to be obtained for the valley as a whole. Several possible combinations of reservoirs, supplemented by moderate channel improvement to carry their discharge, were found to cost less than the Dayton local protection by channel enlargement.

This discovery focused all further work on control by retarding basins. The best basin combination was worked out, and trial estimates of various amounts of channel improvement were made, to balance against the cost of increased reservoir capacity, in order to arrive at the final project. Results in substantially their present form were reached by the beginning of 1915.

In the meantime the state legislature had passed the act allowing conservancy districts to be formed, so that the machinery for joint action of the valley was available. The clinching argument for joint action lay in the fact, shown by the full estimate of cost, that no part of the valley could provide for itself alone at less cost than its share of cost of the general project, or at as low a cost.

Five retarding basins were embraced in the scheme, as the map, Fig. 2, exhibits. Three lie just above Dayton, in the three main streams that join within the city—the Taylorsville basin on the Miami, the Huffman basin on the Mad River and the Englewood basin on the Stillwater.

TABLE 1 DATA OF THE RETARDING BASINS

Basins	Dam Height, Ft.	Dam Length, Ft.	Drainage Area, Sq Mi.	Spillway, Elevation	Water Surface at Spillway, Acres	Capacity at Spillway Acre-Feet	Inches of Runoff on Drainage Area Instantaneous	Inches of Runoff on Drainage Area Three-Day Filling with Outlets Discharging
Germantown....	107	1,210	270	815	3,520	106,000	7.30	10.75
Englewood	124½	4,660	651	876	7,930	312,000	8.99	10.70
Lockington.	78	6,400	255	938	4,020	70,000	6.68	10.00
Taylorsville	78	2,980	1,133	818	11,000	186,000	4.42	9.51
Huffman...	73	3,340	671	835	9,180	167,000	4.66	9.52
					35,650	841,000		

These throttle the extreme concentration that takes place here at the base of the main fan of the valley. Of the other two, the Lockington reservoir controls the upper Miami and thereby protects the cities of Piqua and Troy, while the Germantown basin, on Twin Creek, reduces an important flood contribution to the Middletown flow.

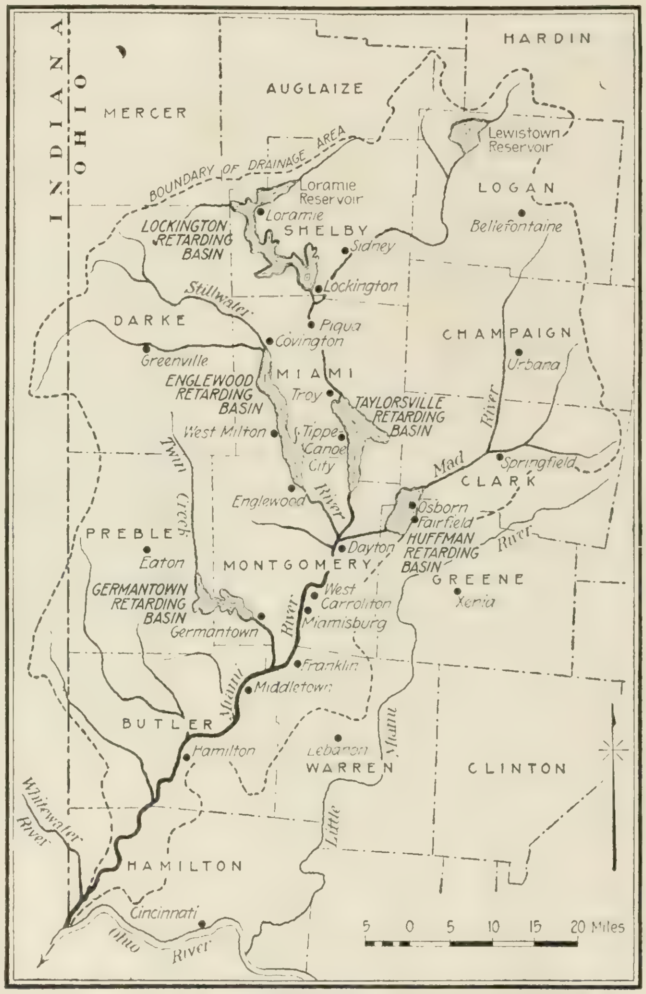


FIG. 2. MAP OF MIAMI VALLEY, WITH LOCATIONS OF THE FIVE RETARDING BASINS TO BE BUILT

Table 1 gives numerical data on the basins and their dams. Each dam is pierced by two to four large conduits, permanently open, located at the base of the dam. These are to pass the normal river flow, and in floods are to discharge water under head. No gates, stoplog notches or other closure devices are fitted. The entrance is protected from drift by piers and a floating boom.

Enormous volumes of water will be discharged from the conduits at maximum flood. It should be remarked that the conduits are so proportioned in relation to drainage area and basin capacity as to let the basins fill approximately to spillway level in the assumed ultimate maximum flood. Spillways are provided, with 15-ft. to 19-ft. freeboard below dam crest, as a pure safety margin, which

amounts to about 10% over the maximum flood. In case of a flood twice as great as that of 1913 the dams would have a freeboard of 5 ft. The insurance of this freeboard in such a case finally determined the heights of the dams. The Germantown, Englewood and Lockington dams required a greater freeboard than 15 ft. above the spillway to meet the second condition.

Table 2 gives the conduit discharges in second-feet for the ultimate maximum storm, when the basins are filled to spillway level. These discharges involve velocities of flow amounting to over 55 ft. per sec. at several of the dams.

TABLE 2 CONDUIT DISCHARGES FROM THE BASINS WHEN FULL TO THE SPILLWAYS

Basin	Discharge Sec.-Ft.
Germantown	10,000
Englewood	12,000
Lockington	8,830
Taylorsville	536,00
Huffman	35,000

Balancing Basin and Channel Work

The most desirable combination of basins and channel improvement would be that one costing the least to build. This balance could be attained in the Franklin County Conservancy project (Columbus, Ohio). In the Miami project it is nearly attained, but not quite. The limiting factors were certain conditions affecting the basin storage.

To develop the ideal capacity of the Taylorsville basin would submerge much of Tippecanoe City, a village some five miles above the dam. Troy, lying several miles farther north, would possibly also be affected. Similar conditions apply to the Huffman basin, where the cost of more radical railway readjustments would be prohibitive.

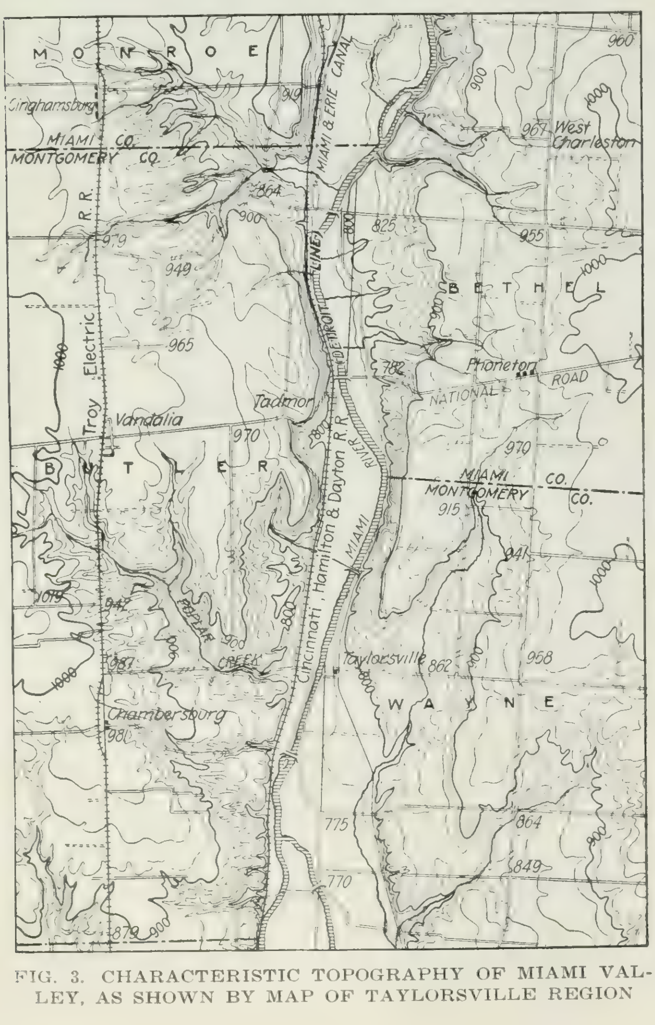


FIG. 3. CHARACTERISTIC TOPOGRAPHY OF MIAMI VALLEY, AS SHOWN BY MAP OF TAYLORSVILLE REGION

In consequence these two basins are of smaller capacity than the others, relative to their position and drainage area. The result is seen (Table 2) in the large discharge rates of 55,000 and 35,000 sec.-ft. for the two basins when full to spillway. The sum of these two figures alone gives a flood flow equal to the entire present capacity of the Miami River Channel at Dayton.

With respect to the other basins, it may be said generally that larger capacity could have been secured without difficulty. The additional benefit would be small, however, The Englewood basin already has a capacity so large that three weeks will be required to empty it after the maximum storm. This basin, by the way, supplements Huffman and Taylorsville in vital manner, because it reduces the Stillwater's contribution to flow at Dayton from 88,000 to 12,000 sec.-ft. The Germantown basin will not economically bear much enlargement, because the flow is already reduced from 66,000 sec.-ft., in the case of the 1913 flood, to 9000 sec.ft.

In spite of these modifying factors it may be put as an approximate fact that just so much channel work is to be done and basins of such size provided, that the total cost of the whole enterprise is a minimum, while securing full protection to the entire valley in all great storms.

The cost figures are briefly summarized in Table 3. Of the figure for channel work and local protection, only a little over $2,000,000 represents cost of channel enlargement, or work that might be saved by increasing

TABLE 3. COST OF MAIN ITEMS OF THE MIAMI WORK

Retarding basins, not including real estate	$6,735,000
Real estate in retarding basins	3,500,000
Channel work and local protection	3,468,000
Real estate other than in basins	2,200,000
Public utilities, relocations and damages	2,307,000
Total, not including interest, taxes, administration and contingencies	$18,210,000

the storage. Against this stands the figure of $5,000,000 as the cost of increasing the storage by any material amount.

Factors Favoring Retarding Basins in the Miami Valley

The great novelty of the Miami project invites attention to the special features contributing toward the easy superiority of retarding-basin control in this valley. An inquiry indicates the following points as bearing on the question:

The River Is Flashy—A remarkably high ratio of maximum to minimum flow is found in the Miami, about 1000. Floods are not only large, but sudden. The river is characterized by two-day to three-day floods, with flows of 100 sec.-ft. per sq.mi. The Seine at Paris, which is not without serious floods, carries at the maximum 87,000 sec.-ft., from a drainage area of 17,000 sq.mi.; its floods last a month or two. The Miami, at Dayton, with one-seventh as large a drainage area, has floods three times as great, which are over in four or five days. The valley has a high concentration rate, due to its highly fan-shaped arrangement and to its straight supply channels.

Retarding basins are concerned primarily with the aggregate discharge; hence slow, long-continued floods preclude their use. Channel improvements have to deal with *maximum rate* of discharge, irrespective of aggregate discharge; hence channel improvement is the more difficult the more flashy the stream. The latter consideration

applies with special force when the greatest floods are to be provided for, as was desired in the Miami.

Good Basins—The region is flat, and to the eye appears devoid of reservoir possibilities. Yet its valleys are wide but well-defined steep-sided grooves in the upland. They have a flat longitudinal slope and a level floor transversely. Thus they are capable of providing very large storage volumes, if a dam site can be found. The topography is represented characteristically by the map, Fig. 3, at the Taylorsville dam.

Ample Storage Capacity—The storage capacity that can be developed is not so closely limited as to be adapted only by lucky chance to the ultimate maximum flood flow. Arthur E. Morgan, Chief Engineer, expresses the view that if the flood runoff to be protected against were as great as 20 in., in place of 10 in., yet retarding-basin control would still be the principal hope (or better, the only hope).

It is important to observe that villages are rather thinly scattered in the valley. Were there more frequent villages or towns, the development of adequate basins would involve considerably greater cost in the way of damages.

Many Dam Sites Available—Good dam sites exist (see Fig. 4); in fact, there are more than need be utilized. Due to the shape of the valley sections, moreover, the dams are cheap. Those actually designed cost $6 to $16 per acre-foot of storage capacity, or about $300 per million cubic feet on the average ($13 per acre-foot).

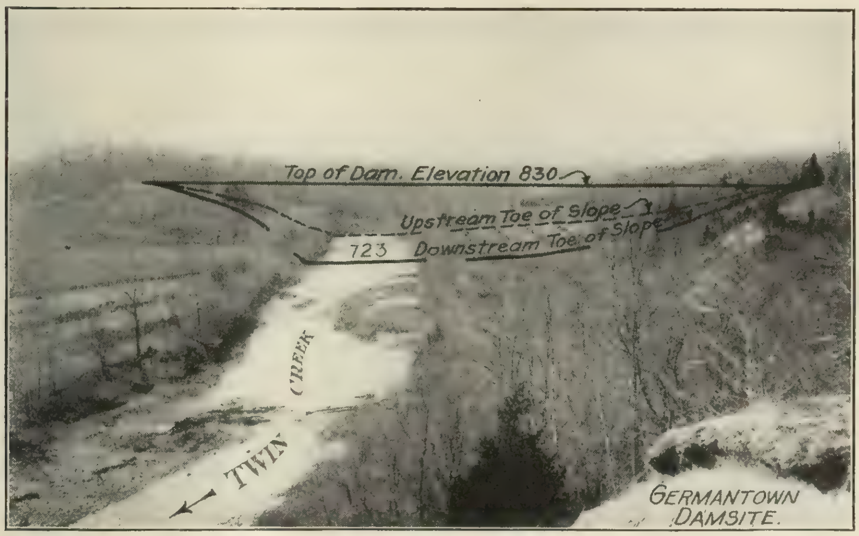


FIG. 4. GERMANTOWN DAM SITE, SHOWING VALLEY TOPOGRAPHY IN THE MIAMI AREA

The other dams are much longer, but abut against valley sides of similar form and character.

The Miami plan is unique in being a device for securing *complete* protection against the largest floods ever possible. In this respect as well as in the admirable way it was worked out, it stands as a model, and as an object for most careful study by future workers in flood protection. The fact that the valley is rather unusually well adapted to basin control is perhaps the chief or only natural condition that facilitated the engineers' planning. An ample supply of money for full investigation was the great outside advantage.

Arthur E. Morgan has been Chief Engineer of the project from its initiation; Daniel W. Mead, a member of the Board of Consulting Engineers, acted as Chief Engineer of the District during an illness of Mr. Morgan, and was frequently consulted during the preparation of the general plan, the working out of the details of construction, and the writing of the specifications; S. M. Woodward, Consulting Engineer, and Kenneth C. Grant were responsible for the hydraulic studies and calculations throughout the preparation of the plans; O. N. Floyd, engaged upon the project from its beginning, personally directed much of the field work, has kept in close touch with all the engineering details, and has been largely charged with the innumerable negotiations with public service companies during the development of the project. C. A. Bock has been Office Engineer during the preparation of the plans.

Tile Drainage in Wet Cuts

Vitrified tile has been used extensively on the Missouri Pacific System for draining water-pockets and wet cuts. Of 714 locations about 11% were reported as failures, due either to insufficient depth or improper installation. Investigations were made at various locations and the results are stated as follows by W. C. Curd, Drainage Engineer of the system, in Bulletin No. 189 of the American Railway Engineering Association:

The investigation showed a remarkable benefit to have been derived through the strengthening of roadbed where drains had been properly installed. Estimates indicate a return of 50 to 200% per year in the decreased cost of maintaining line and surface on the short pieces of track that were drained. The failures were found to be due principally to improper installation, particularly with reference to depth of drain to the moving material in the roadbed. The necessity for tiling cuts comes from neglect to provide and maintain adequate surface drainage. Just as efficient, if not better, track could be developed if cuts were protected by intercepting and side ditches properly constructed and maintained, but tile seems to afford the only practical relief where the roadbed has become water soaked and too soft to sustain the loads. Drains should be laid with bell-end vitrified salt-glazed sewer pipe of 6-in. minimum diameter, with unsealed joints. The top of tile should be 12 in. below frost line and a minimum distance of 12 in. below unstable or moving material. Tile should be laid to grade established by level, and with all the fall obtainable. The center line of tile should be parallel to and from 4½ to 7 ft. from center of track.

Tile should be placed directly on the bottom of the trench. After it is laid to line and grade, and before backfilling, it should be covered with straw, grass or some such material to prevent loose particles in backfilling from entering the joints. Trenches should be backfilled with cinders, coarse material being placed directly around and over the tile. Where the sides of the trench show signs of distortion from passing loads, a sufficient quantity of riprap or coarse stone should be mixed with the cinders to brace the walls.

Pockets under track should be tapped with cinder-filled lateral trenches, and connected with the tile-drain trench, but without connection with tile drain except through the unsealed joints. Remove all surface water from cuts by intercepting and side ditches; otherwise the tile drain may be overtaxed and eventually fail entirely.

After drains have been installed, it is essential to maintain free outlets to prevent backing water into the tile. The ends of drains should be surrounded and supported by concrete or dry masonry to guard against underwash. To prevent small animals from entering tile, the outlet should be protected by rods or grating. Failures of drains come from the following causes: Insufficient depth below moving material, shifting grade or alignment causing joints to open, insufficient grade to provide proper flow, location of drain in impervious material without providing adequate means for tapping saturated material with lateral drains or cross-trenches, distortion of walls of trenches.

Adding Three Stories to Engineering Societies' Building

SYNOPSIS—The decision of the American Society of Civil Engineers to join the other engineering societies in their headquarters building in New York City necessitated the enlargement of that building, a modern steel frame structure. Article gives in detail the structural work of adding three stories to a 12-story building.

Placed on steel stilts some 200 ft. high, the new superstructure of three stories which is being built on the Engineering Societies' building at 25 West 39th St., New York, to accommodate the American Society of Civil Engineers and to increase the library space by the addition of an entire stack floor, will be a structure of bold and novel character. The design represents the solution of a problem at first considered impossible. Both architecturally and structurally, the task of building the three additional stories over the present roof of the building offered the most serious difficulties.

The Architectural Problem and Its Solution

The top of the present building is occupied by the large joint library, housed in a hall spanned by trusses carrying the roof. The three-story addition is to be placed directly over the library, starting from the level of the present ceiling, just below the roof trusses. But the library is not the only large-span room in the building. The main auditorium on the third floor and several meeting rooms on the fifth and sixth floors interrupt the continuity of the column system and, with the library, stand in the way of providing direct support for ordinary beam framing in the new floors above.

The esthetic phase of the problem was very difficult. The exterior architecture of the old building was strictly proportioned to the original height and the development of its upper part appeared to preclude the possibility of building over it with satisfactory esthetic effect. After making numerous studies, however, it appeared that the very restrictions imposed by the structural conditions afforded a happy solution of the esthetic problem. The truss framing that had to be used to carry the new load made it virtually necessary to set back the walls of the added stories. This arrangement suggested a penthouse or tower effect, and on working this out in due proportion to the old building a satisfactory result was secured. The added mass does not weigh down the old cornice, and, it is believed by those directing the work, the effect is that of a building structurally and architecturally homogeneous.

Devising Means for Carrying the Superstructure

Because of the open spaces in the building, a wide-span construction was necessary. The walls and available columns of the building were incapable of carrying any considerable added load, however; and with respect to reinforcing the old columns there were such serious objections as to make this expedient very undesirable.

At first it seemed impossible to find locations for running up new columns without cutting into meeting rooms or otherwise injuriously affecting the occupancy or interior arrangement of the old building. Finally, however, a careful study of the floor plans showed that at four points near the corners of the existing auditorium it was possible to run up new columns passing everywhere through walls or partitions or through duct spaces. At two of these points, moreover, the new column would be close to an existing column to which it could be braced. This at once furnished the solution of the structural problem, the frame of the new superstructure being developed as a cage supported by a series of trusses resting on the four new columns except for a small amount of weight transferred to the old side walls. The project was worked through on this basis, and the contractor is now building it in accordance with this design.

The two floors of the old building which made the most difficulty with respect to column locations, the floors under and above the large auditorium, are shown in the plan, Fig. 1, and superimposed on this framing is shown the location of the new columns and the trusswork to be placed above the old roof. One of the new columns is set in a freight elevator, another in a flue, a third in a space that is partly stair well and partly duct space, and the fourth in a partition.

Two problems of detail in working out this scheme were, (1) provision of suitable foundations for the new columns, and (2) staying the columns laterally. How the foundation problem was worked out is shown by Fig. 4, which represents two of the new footings. The new columns in all cases come so near to old columns that the foundations partly coalesce. In one case the new column is provided for by adding an extension at one side of the old pier and thus making a composite foundation. In the other cases the new columns have footing piers on either side of the old foundation with girders on top of the new piers straddling the old foundations and designed to carry the new columns.

The columns are stayed against buckling by tie-connections either to adjoining columns or to floor beams. Fig. 5 shows typical connections of both kinds.

No New Bracing Provided

The new columns do not include any means of wind bracing. Therefore the wind pressure against the new superstructure will be transferred into the frame of the old building and be absorbed there. However, the old building contains no diagonal bracing, knee-brackets, or rigid beam-connections, but depends for lateral stiffness entirely on the resistance of the brick walls. With the structure as enlarged these brick walls will have to carry the additional lateral load that may come on the three new stories.

The original design of the building was made under the old New York City building code. The revision of this code, completed a year ago, permits greatly reduced thickness of outside walls in steel-frame buildings and makes other changes favorable to structural design. The old walls therefore have a large excess of strength, when judged by the new law, and the designers considered that some additional load could be placed on the walls.

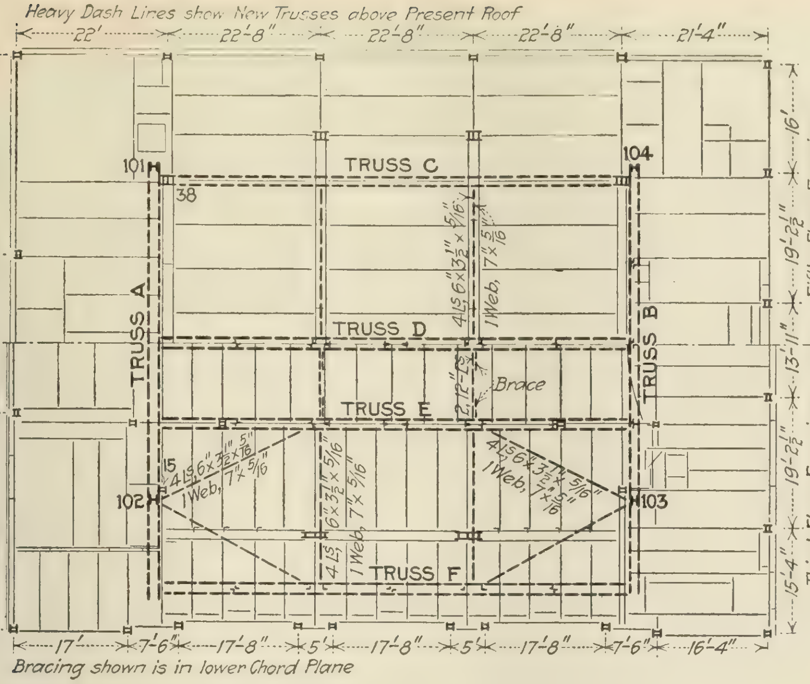


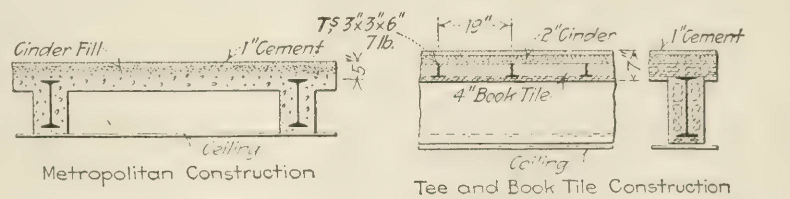
FIG. 1. POSITION OF NEW COLUMNS AND TRUSS SYSTEM (15TH FLOOR) WITH RESPECT TO OLD FRAMING (THIRD AND FIFTH FLOORS)

and south cantilevering forward over the southerly pair of columns. Four east-west trusses frame into them. Provision for passageways through the trusses is made by short central panels without diagonals in the main trusses, and by a portal arrangement of the sway bracing between the middle transverse trusses. The trusses are below the 15th floor, and their bottom chords are at half-height of the 14th story. This story is to be used as a stack room of the library, and the bottom-chord level is at the intermediate platform level of the book stacks. Lateral bracing is placed at this level to stay the tops of the columns. A top-chord system of laterals is built into the framing of the 15th floor. The 14th floor is suspended from the trusses by hangers. Its beams come directly over the existing library ceiling, and are to be placed without disturbing the ceiling. The old roof trusses will be left in place until the new steelwork is erected and the ceiling beams hung to the beams of the 14th floor. The new work includes about 686 tons of steel.

Elevator service to the new floors will be obtained by extending the three present elevator shafts up to the new roof. Incidentally, new machines will be fitted, traction elevators replacing the present drum machines.

The work is in charge of a joint committee of the several societies. H. H. Barnes is chairman. Charles Warren Hunt represents the tenant of the new stories—

The outer bay of beams in the (new) 14th floor rests on top of the old wall. These beams carry not only their own floor and roof loads but also, at some points, the load of the outside columns in the 14th story, as can be seen from the plan Fig. 2. Along the west and north walls, moreover, the outer wall is continued up vertically, so that three added stories of wall and floor loads come on these walls. While the old wall is carried on a wall girder at each floor level, the added load is assumed to transmit down through the brickwork, without increasing the stress in the old wall girders. The wall is regarded as a bearing wall with respect to the added load, and as a curtain wall with respect to the original load. The structural arrangement of the new floors is simple except for the 14th floor, which is suspended from the trusses. This floor comes directly over the ceiling of the present library, and its construction was planned such as to create the least possible risk to the library from drip or falling material. Book tile 4 in. thick, to be covered by a cement floor, were therefore adopted; 3-in. tees 19 in. apart are provided to carry the book tile. The other floors are to be of Metropolitan type reinforced-concrete slab floor, which type was chosen for its light weight. Weight also dictated the design of the outside walls, which are to be 12 in. thick, comprising 8-in. hollow tile and 4 in. brick facing. The column loads of this new superstructure are large; Col. 101, 768,000 lb.; Col. 102, 1,494,000 lb.; Col. 103, 1,537,000 lb.; Col. 104, 878,000 lb. Drawings of the truss construction are shown by Fig. 3. Two main trusses run north



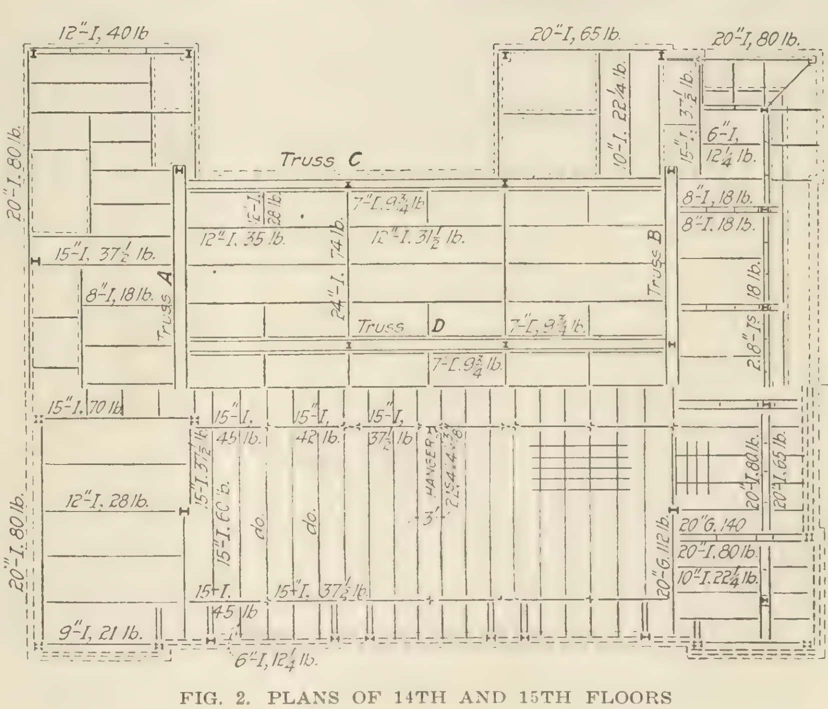


FIG. 2. PLANS OF 14TH AND 15TH FLOORS

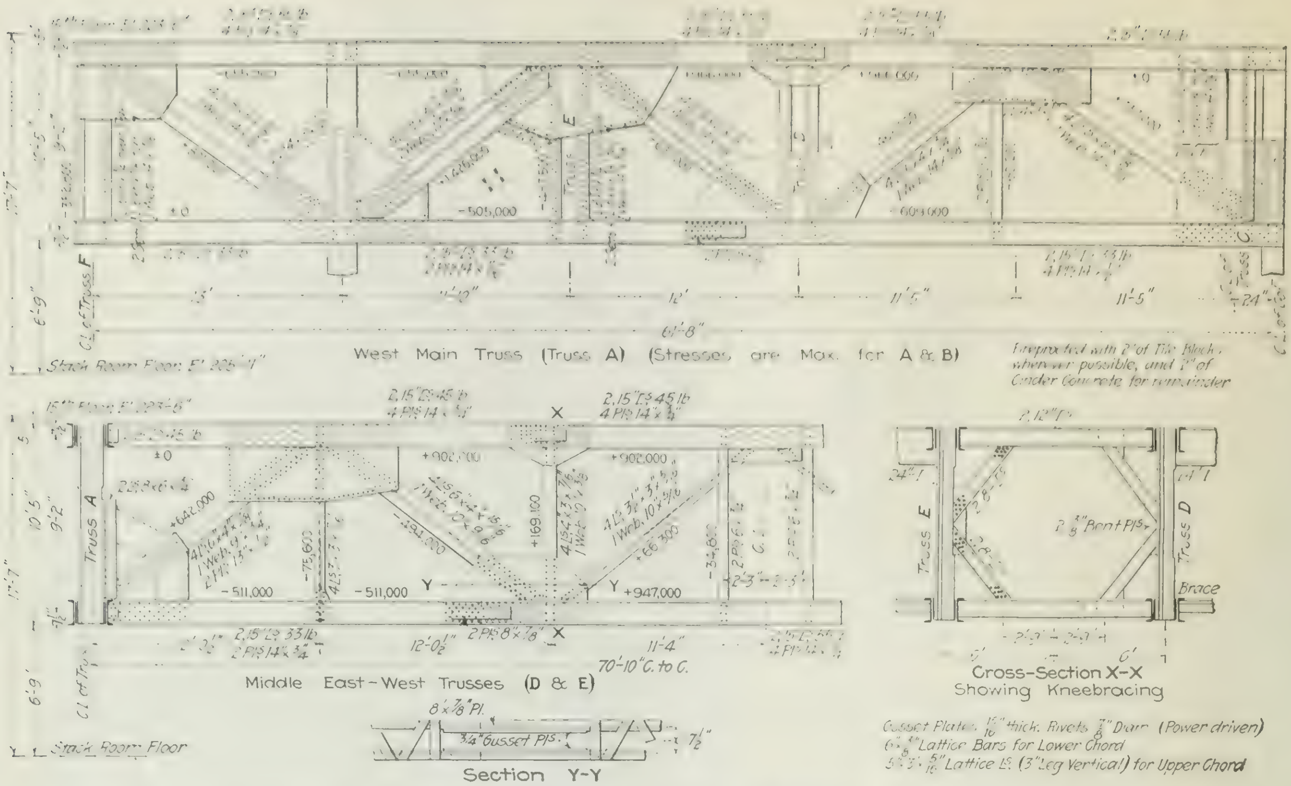


FIG. 3. TRUSSES CARRYING NEW SUPERSTRUCTURE OF ENGINEERING SOCIETIES' BUILDING

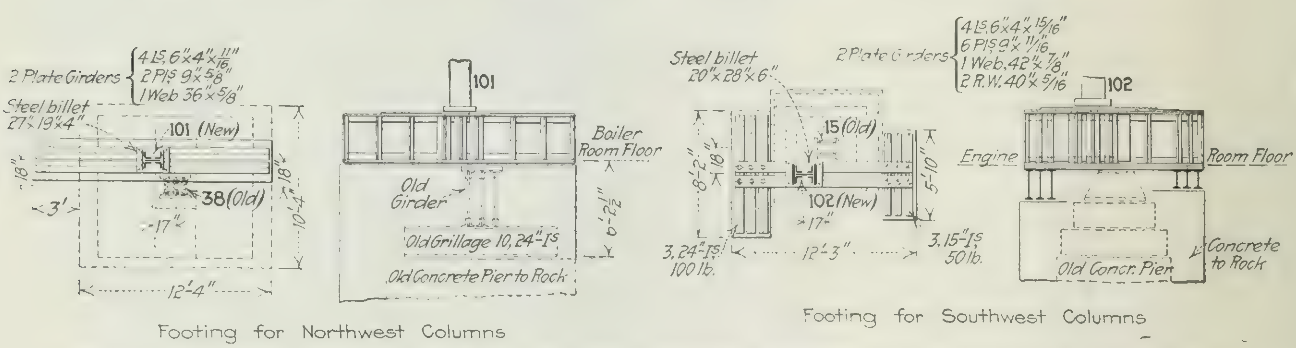


FIG. 4. FOOTINGS OF TWO OF THE NEW COLUMNS, SHOWING METHOD OF ENLARGING OLD FOOTINGS

the American Society of Civil Engineers—and is in charge of publicity for the committee. H. G. Morse, of 101 Park Ave., New York City, is architect. Purdy & Henderson, 45 East 17th St., designed the steelwork. Wells Construction Co. is the contractor. Mr. Morse was associate architect with Hale & Rogers in the construction of the original building. Similarly, Purdy & Henderson were the structural engineers and Wells Bros. the contractors for the old building.

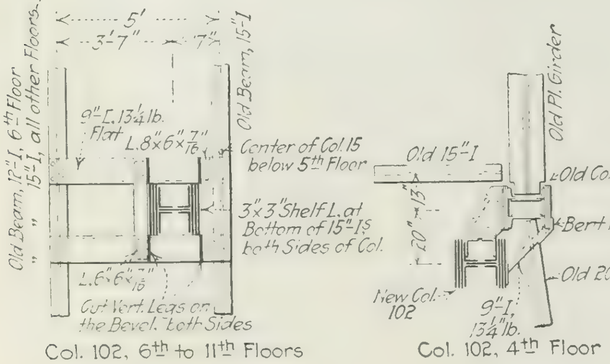


FIG. 5. TWO TYPICAL STAY-CONNECTIONS OF NEW COLUMNS

Anecdotes of I. K. Brunel, the famous English engineer, are related by the London correspondent of the "Indian Engineer," who was Brunel's last pupil. In building the suspension bridge at Hungerford, England, in 1836, to facilitate construction an iron bar 1½ in. in diameter and 1,000 ft. long was hung across the gorge and traversed by a basket worked with ropes. Passengers were allowed to make the journey at fares from 25c. to $1.25. An engaged couple got into the basket and were hauled out over the gorge, when something went wrong with the ropes and they passed the night suspended midway over the Avon. Brunel was an athlete and a man of great daring. At one time when he desired to drop a heavy plumbline from the top of the cliff to the bottom he had a 3-in. plank shoved out over the edge of the cliff, and three men stood on the land end while he walked out on the end overhanging the gorge. He was accustomed to travel in his own carriage, drawn by four horses driven by two postilions. His valet rode in the dickey behind and used to hand cigars to his master through a hole in the back. For winter traveling the floor of the carriage was filled with straw, and one day this caught fire from the spark of a cigar. The valet called for the post-boys to stop, but Brunel opened both carriage doors, told the boys to drive on and kicked the straw out. In one of the Thames tunnels, when caught with several workmen in an inrush of water, he remained last of the lot to get out and then only with a broken leg from the impact of being washed against the shaft timbering.

Large Levee and Drainage System in Indiana

SYNOPSIS—Low lands drained and higher lands protected from flooding by 37 mi. of levee with drainage outlets fitted with flood gates. Dragline and wheeled-scraper work. The methods of construction are described.

Southwest of Vincennes, Ind. (in Knox County), is a tract of land of about 50,000 acres lying between the Wabash River and White River, and subject to overflow during high-water periods. The soil is rich and favorable for growing good crops, and the value of the land will be very much greater when good crops can be depended upon, without fear of floods. To protect this area, a system of about 37 mi. of levee is now about completed, with an aggregate of 1,684,350 cu.yd. of earthwork. This is known as the Brevoort levee system.

From the west boundary of the City of Vincennes a stretch of levee extends 21 mi. along the Wabash River nearly to its junction with the White River, a ridge of high land serving to close the lower end of the district. A second stretch of levee extends 10 mi. from this ridge along the White River. This ends at a low hill, beyond which is a 6-mi. stretch of levee along the River Duchee. Culverts with flood gates provide for the escape of drainage water, and eventually a pumping plant may be installed at the lower end of the district to take care of such water during flood periods.

The engineer for the Brevoort levee system is Jacob S. Spiker, of Vincennes, Ind., and he also acts as Superintendent of Construction on behalf of the landowners. The general contract was let to the MacArthur Brothers Co., of Chicago; the greater part was sublet to the W. J. Hoy Construction Co., of St. Paul, Minn., and the remainder to Oakford & Hutchinson, of Chicago. The Vincennes Bridge Co., Vincennes, Ind., has the contract for concrete culverts and flood gates. The total cost of the levee, with culverts and other works, will be about $450,000. The City of Vincennes will pay $10,000 and three townships will pay $32,755 on account of the road improvements. The balance of the amount is raised by assessment upon the landowners. The contracts were let Apr. 1, 1916, and required completion of the work by Dec. 1, in order to give protection against the spring floods.

The levees are 4 ft. wide on top, with side slopes of 2 on 1 and with a berm of 15 ft. between the borrow pits and the toe. The top is 3 to 5 ft. above the flood level of 1913. For the greater part of their length the levees are entirely new fills, but in places they are enlargements of existing (but lower) levees. The slopes are left as formed by the material dumped from the excavators, with no dressing or sodding, but they will be

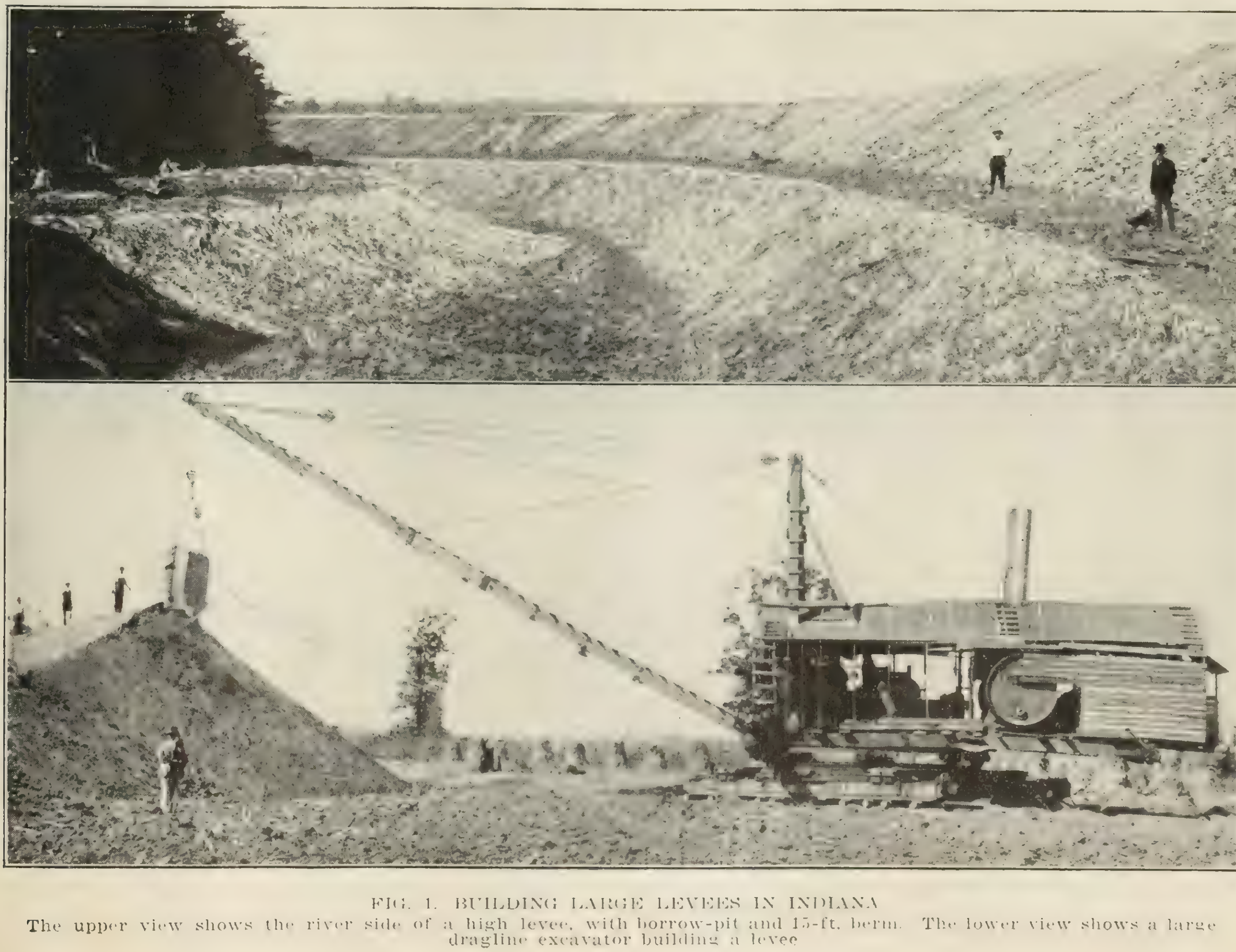


FIG. 1. BUILDING LARGE LEVEES IN INDIANA
The upper view shows the river side of a high levee, with borrow-pit and 15-ft. berm. The lower view shows a large dragline excavator building a levee

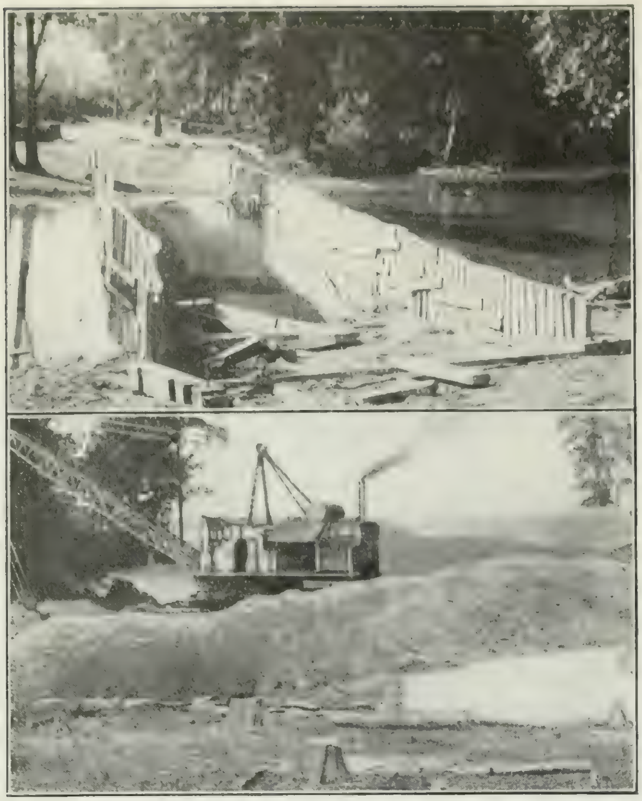


FIG. 2. LEVEE CONSTRUCTION WORK

The upper view shows double line of sheetpiling in base of levee crossing a stream. The lower view shows an excavator handling material from borrow-pit to spoil bank, to be placed later in the levee at the right. In the foreground is the outlet end of a concrete culvert.

sown to grass by the farmers and landowners. For enlargements, the old slope is cleared of grass and weeds and plowed before depositing the new fill.

The ground forming the base of the levee and the berm is cleared of trees, brush, logs, stumps, etc. Heavy stumps are blown out or pulled up, except that on the berm they may be cut off at the ground level or left 10 in. high. The base of the levee is plowed, teams being used for this work. Under new levees, a muck ditch 4x4 ft. is excavated, having the sides as nearly vertical as possible and not exceeding a slope of 1 on 1. Teams and slip scrapers are used for this excavation.

The material is mainly dry, including sandy and clayey soil. The former holds better against the water, as it packs hard and does not slough so much when water rises upon the slope. Part of the heaviest borrow-pit cut was in dry clay so compact that it had to be loosened by blasting before the shovels could handle it. In two or three places wet muck and soft clay have been encountered. The latter caused a slide in the fill; but after this had dried out and settled, it was covered with sand (brought up to the required levee section), and no further trouble is expected.

All material is taken from borrow pits on the outer, or river, side of the levee. A berm of at least 15 ft. is left between the borrow pit and the levee, and the depth of pit must not be so great as to encroach upon a 1:3 slope extending from the toes of the levee. The borrow pits are not continuous, but at intervals of not over 300 ft. there are traverses, or cross-banks, left, 14 ft. wide. To provide for continuous drainage through the pits, however, a cut is made across the land end of each traverse. Fig. 1 shows a long stretch of high levee.

With dragline work the levee fill is built up in two lifts as a rule, the first lift being shallow and covering the full width of base. The second lift is made by dumping the material at the level of the top of the fill. The largest machines, however, make the fill at one lift, as shown in Fig. 1. A man on top dresses the fill to grade and width. The maximum height is about 30 ft. On that part of the work shown at the bottom of Fig. 2 the height of levee and distance from borrow were too great for direct filling. The excavator therefore placed the material from the borrow pit in a spoil bank and then rehandled it from the bank to the levee.

On new work, the engineers set out center and slope stakes at 100-ft. intervals. On enlargements, the excavator follows the old levee, and the men on top of the fill keep the grade by sighting over three stakes with targets or boards.

The greater part of the work is being done by dragline excavators, but for about 8 mi. where the fill is low the work is done by wheeled scrapers. Here a force of about 125 scrapers is employed when in full progress, but this part of the work has been delayed owing to farmers

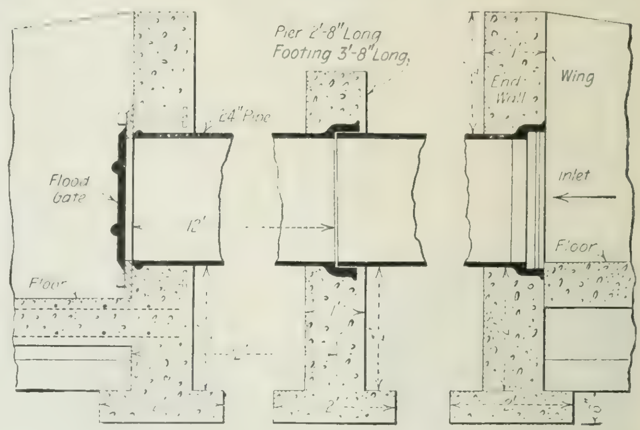


FIG. 3. CAST-IRON PIPE CULVERT, WITH CONCRETE SUPPORTS AND FITTED WITH FLAP GATE

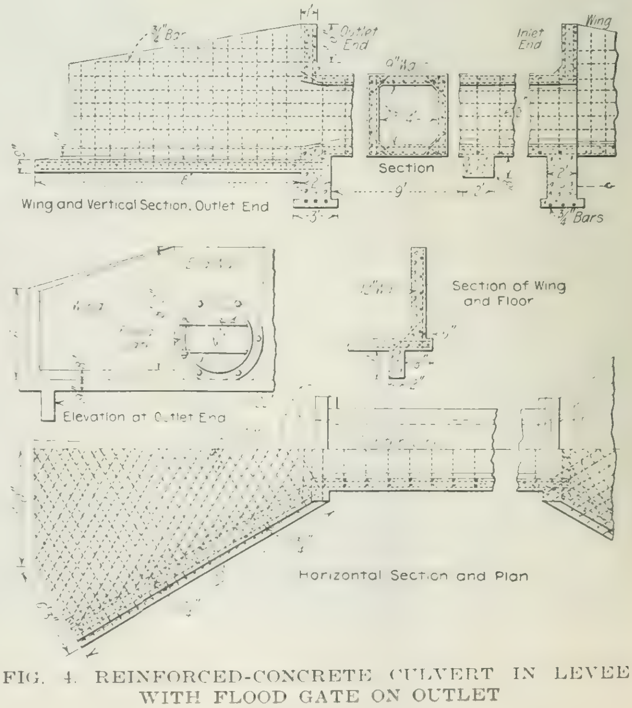


FIG. 4. REINFORCED-CONCRETE CULVERT IN LEVEE; WITH FLOOD GATE ON OUTLET

having to employ their teams on the land and having none to rent for handling scrapers. With this method of working the levee is built up in successive horizontal layers. The fill is made to allow for a shrinkage of 20% in dragline work and 10% in wheeled-scraper work.

There are 12 dragline machines now at work, and one more is being erected. The larger ones have 2- and 2½-yd. buckets, while two machines handle a 3½-yd. bucket on an 80-ft. boom. The machines are of the Bucyrus, Monighan and Lidgerwood types. These last (Fig. 1) have timber frames and booms and are erected on the site.

Most of the machines travel on rollers, but a few have caterpillars or are mounted on wheels on wide-gage tracks. The buckets have no teeth for working in sandy and wet soil, but only for hard compact soil. Coal is distributed by teams. Water is obtained at almost any point by well points driven 12 to 15 ft. into the ground and connected with a steam pump. The work is carried on in two 10-hr. shifts daily. For night work, electric light is used on the excavators, and acetylene and oil torches are used on the fill.

Where the levee is carried across the River Duchee, two parallel lines of sheetpiling are driven for a distance of about 170 ft., as shown in Fig. 2. These lines are 20 ft. apart and driven to a depth of 14 ft. They are single lines of 4x12-in. water-oak sheetpiles, not interlocked. Sheetpiling is used also under the culverts and gate openings. Round piles are used for foundations at these places.

Culverts and Open Drainage Channels

Where the work consists of enlarging and raising old levees, the new material is dumped on the outer, or river, side, the old slope being cleared and plowed so as to give a good bond or union for the new material.

The smaller culverts are of 18- to 36-in. cast-iron pipe, using lock-joint pipe in short lengths, with concrete under alternate joints. The ends have concrete head walls with wings and aprons, and the outer end is fitted with an automatic flood gate. These cast-iron flap gates have the hinge placed diagonally so that the gate closes by its own weight (or the pressure of water on the outside) except when the flow of water from the inside is sufficient to force it open. Larger culverts are of reinforced concrete, of box type, rectangular in section. The largest are 5x5 ft., but have the outer end tapered to a 5½-ft. circular section to fit the flood gate. These culverts have 9-in. walls, with 12-in. floor and roof. Figs. 3 and 4 show the culverts and gate construction. Fig. 5 is a view of one of the large culverts with 5½-ft. flood gate.

At two openings where larger waterway is desired, there is an open concrete channel, fitted with rectangular gates sliding vertically and operated by means of gearing. Each gate gives an opening 10 ft. high and 6 ft. 4 in. wide and is operated by a vertical screw or threaded stem working in a ball-bearing nut on a pedestal. The gates were built by the Caldwell-Wilcox Co., of Newburgh, New York. One of these structures has four gates and the other has two. In each case the gates are operated by gearing from a 6-hp. gasoline engine located at the gate.

To set the gates a derrick with 75-ft. steel box-lattice boom, 40-ft. mast and four logs for stiff-legs was erected, one of the stiff-legs bracing the mast against a tree. A ½-yd. mixer with 45-ft. elevator tower was installed, with spouts leading the concrete directly into the forms. The gravel for the concrete was brought from the stock pile in a small car with flat wheels running in small steel channels for rails.

Where the levee is at a distance from the river, roads must be carried over it to give access to the land on the outer side. These roads are built diagonally up the slope on either side, with a grade of 10% and a crossing 20 ft. at the top. They are made 20 ft. wide. In some places the original road along the river bank is closed and a new road built along the land side of the levee.

All concrete is a 1:6 mix, made with local washed gravel, in sizes ranging from 1¾ in. to fine sharp sand and with not more than 15% of voids. Wood forms are used. Deformed bars serve for the steel reinforcement.

There is a camp for the assistant engineers, inspectors, etc. It has sleeping accommodation for four or five men, but has to provide meals for 14 to 16 men. The contractors have their own camps.

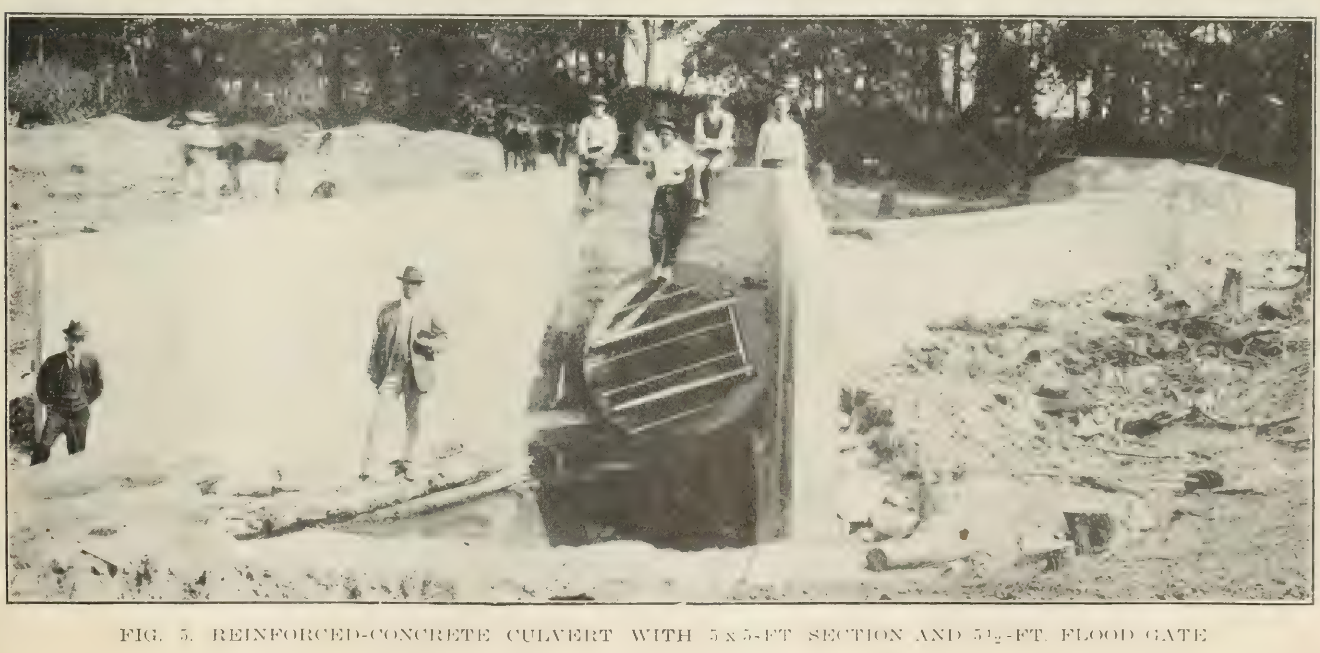


FIG. 5. REINFORCED-CONCRETE CULVERT WITH 5x5-FT. SECTION AND 5½-FT. FLOOD GATE

Notes from Field and Office

Concrete piles exposed after placing—Mending a tape in the field—Cold bituminous mixtures for plank floors of highway bridges—Keeping tab on revised drawings—Portable timber-framing machine—Keeping Los Angeles engineering records

Concrete Piles Not Affected by Deep Foundations Sunk Alongside

Good performance of concrete piles under unusual conditions was recorded during the construction of the new Waterside power-house extension of the Louisville Gas and Electric Co. on the south bank of the Ohio at Louisville. Foundations for building columns were constructed before the condenser well inside the turbine house was sunk. The column foundations consisted of "Pedestal" piles placed for a working load of 30 tons and (on testing one pile in each group) showing generally only about $\frac{3}{16}$- to $\frac{1}{4}$-in. settlement under 60-ton test load. Later, the condenser well, 55x64 ft., was sunk between the turbine-house column foundations.

This well passed close to a number of the pile groups. It was put down by sinking the reinforced-concrete well structure by open excavation inside and loading on top. No trouble was found in keeping down the water in the bottom of the excavation; and the soil gave no difficulty, although pretty heavy loading applied by a sand box on the upper rim of the well had to be used in order to get it down to its final depth of about 56 ft. The side of the well passed so close to some of the piles that part of the side of a pile had to be cut away to provide safe clearance for the well.

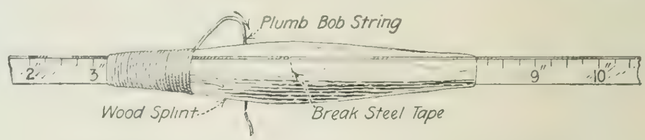
Because of this proximity of the piles it was thought that the near pile groups might have been weakened in bearing power. A suitable selected pile was therefore subjected to a load test. The loading was carried up to 57 tons without any indication of reduced bearing power. The conclusion was that the piles were unaffected and had just as high load capacity as before sinking of the well.

The engineers for the design of the new station are H. M. Byllesby & Co., Chicago, Ill. The construction of the new station is being done by company labor.

Field Mend for Steel Tape*

By Hale H. Hunner†

Although there are several quick-repair menders for steel tapes on the market, it usually happens that they are in the office when the tape breaks. I was taught this simple mend by a practical surveyor several years ago, and



MENDING A TAPE WITH WOOD AND STRING

have used it a good many times since and never had the least bit of trouble in making it hold as long as I cared to leave it on. I have worked for a week in the woods with two of them on the tape without having to be touched except for an occasional soaking.

*Reprinted from "Engineering and Mining Journal."
†920 Third Ave., Hibbing, Minn.

CONCRETE PILES EXPOSED BY CONDENSER-WELL PIT

When the tape breaks, cut a straight piece from a green alder or willow about 3 in. long. When the stick is split down the center and peeled, it should just cover the tape laid lengthwise. Smooth up the split faces and shave down the outside from the center of each half to a thin edge. About 3 ft. of plumb-bob string or stout cord will serve to wrap the splints. The cord should be wrapped as tight as possible each time and care taken to see that the binding does not have a chance to slacken up. When the splint is nearly half wound, place the broken ends together right side up and finish winding until the splint is entirely covered. A minute's soaking in water will remove any possibility of slipping. If it should slip at all, it will pull entirely out, thus there is very little chance of getting wrong chainage. It slides through the brush and around rocks with very little hindrance and while it puts a stiff place in the tape the advantage of a quick field repair overbalances the disadvantage.

Keeping Tab on Revised Drawings

By Albert M. Wolf*

In supervising a large concrete building job at some distance from the main office where the detail plans are made, there is ever present a danger that the latest plans may not be used by the field superintendent and the construction gang. The structural plans for a concrete building are seldom completed when bids are called for, the usual practice being to have the footing design and column schedule completed at the time so that the material can be ordered and work started without delay after awarding the contract. The detailing of the superstructure is usually carried on slightly ahead of the construction work, necessitating the issuance of several progress prints of the same plan.

The writer has found it worth while to issue a memorandum at the end of each week, giving the date of the latest print of each plan issued. These memo's are typewritten on standard specification-size sheets. Blueprints are made from them and are sent to the superintendent and contractors, who post them in the various field and main offices. Blueprints are used since they are more conspicuous and more apt to be regarded as a part of the plans than are carbon copies. The following form is used:

PLAN MEMORANDUM

Date................

Building for "A. B. Co." City................

Post in a Conspicuous Place.

The latest prints of plans to be used are dated (with rubber stamp) as follows:

Sheet No......... Description........ Date........

These memoranda are sent out on Saturday of each week, except when only one or two revised prints have been sent out since the last memorandum.

Each time a sheet is revised or some new feature is added, a note regarding same (with date made) is placed on the tracing in a space provided in the title of the sheet. In addition to this each print is marked with rubber stamps as shown herewith.

The upper stamp calls attention to the fact that the print contains some revision or addition not shown on previous prints, and by referring to the revision list (in title) the extent of the change can be found at once. If the print bears a later date than the one noted for this sheet on the memorandum sheet posted in the field office, the memo is revised by the superintendent to show the date of the latest print. In this way a careful record of the latest prints is kept, and anyone not familiar with all

REVISED PRINT
Destroy all prints
previously sent you

THIS PRINT MADE
Dec. 20, 1916

PRINTS MARKED WITH THESE TWO STAMPS
Upper stamp is 3¼x1 in.; lower is 2⅛x⅜ in.

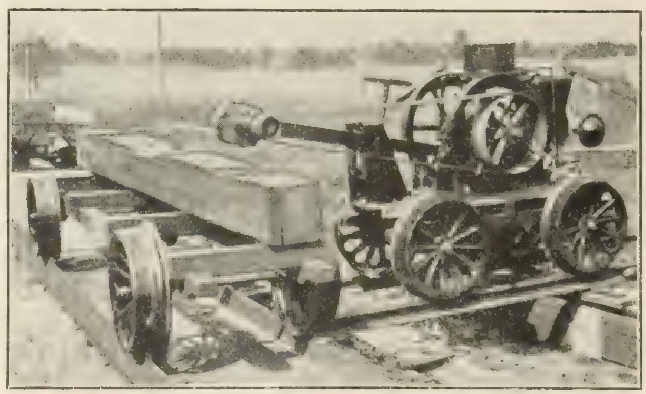
the details of the work can quickly find, by referring to the memorandum sheet, which prints should be used for construction work, and thus costly errors due to use of superseded and void plans are avoided.

*Principal Assistant Engineer, Condron Co., Industrial and Structural Engineers, Chicago.

Portable Timber-Framing Machine Used on Keokuk Bridge

The portable machine for gaining and framing timber for various construction and repair work, shown in the accompanying figure, was used on the new Mississippi River bridge at Keokuk, Iowa, where its work was reported to be quicker and better than hand gaining. Similar machines are built, for sale, by the inventor, J. E. Toohey, of Grand Rapids, Mich.

The machine consists of a small car of 2-ft. gage on which is mounted a gasoline engine driving a cutter head 2 in. wide (for gaining) or a small circular saw carried



PORTABLE MACHINE FOR FRAMING TIMBERS

on the end of a hinged steel arm. The position of this arm is adjustable by means of a screw passing through its heel, and the arm may be clamped to vertical plate guides by a bolt passing through slotted holes in these plates. The timber to be framed is placed on a four-wheel truck running on a track of 2-ft. gage at right angles to that on which the machine stands. By means of a vertical lever attached to one of its wheels, the machine is moved forward and backward, so that the saw or cutter head passes across the timber, making a cut at each stroke. As each cut is made, the truck carrying the timber is moved forward to position for the next cut.

The track for the timber truck on the Keokuk bridge work was made by laying a 24-in. I-beam down flat. The machine track was made of old rails.

In tests made on the Pere Marquette R.R., by C. S. Sheldon, Engineer of Bridges and Structures, three men in a 10 hr. shift framed 400 bridge ties 8x8 in., 10 ft. long, cutting two 13 in. daps or gains in each tie. The cost was $8.25 for labor and 59c. for fuel, or about 2¼c. per tie. Handwork on similar ties cost 15c. per tie. The machine has been used also by the Strobel Steel Construction Co., of Chicago (in the flooring of the new bridge over the Mississippi at Keokuk, Iowa), and by the McClintic Marshall Co., of Pittsburgh.

Building Telephone Conduits

The conduits used by the Wisconsin Telephone Co., at Milwaukee, are of vitrified clay and mainly of the multiduct type. Groups of separate single-duct lines (embedded in concrete) are adopted in some cases for curves, etc. With a single unit of multiple-duct conduit no concrete base is used, but a 3-in. layer of concrete is placed on the top (and extending partly down each side) to protect the conduit from injury in case of street excavation. Most of the work has two or more units of duct, and here a 4-in. concrete base is employed, extending 3 in. beyond each side of the conduit. A 3-in. concrete cover is laid also, with its bottom the same width as the conduit line and its top the same width as the base. Earth is packed along the sides of the conduit between the projecting lines of the concrete.

The concrete for the conduit base and cover and for the manhole floors is a 1:4:8 mix; for the walls and the roof of the manholes it is 1:2½:5. The conduits are laid in 1:3 mortar. Broken limestone is used for concrete. Washed gravel is not found satisfactory, unless it is graded at the work, as it tends to segregate in shipping, so that one load will be mainly coarse and another mainly fine. The concrete base averages 0.0324 cu.yd. per lin.ft. of one-unit conduit.

In building conduits the concrete is mixed in a portable drum mixer of 4½-cu.ft. capacity, driven by a gasoline engine. The machine is not self-propelling. It is located at a street intersection, convenient to a hydrant, and the materials are wheeled to it from a stock pile deposited by motor trucks. The same machine is used in building the manholes and in putting back the concrete base for paving. The concreting gang consists ordinarily of one operator, one man to charge, and three to five men wheeling concrete to the trench, this number depending upon the distance it has to be wheeled.

The use of trenching machines for this conduit work was described in *Engineering News*, Dec. 7, 1916. The construction is done by company forces and is under the direction of C. W. Wilson, Superintendent of Exchange Construction.

Cold Bituminous Mixtures for Plank Floors of Highway Bridges

By B. H. Piepmeier*

There are numerous steel highway bridges in use on which it is necessary to maintain wood floors, primarily because the light flimsy structures that have been built will not carry a heavier floor. A plank floor must be replaced about every five years, and when it is subjected to heavy traffic it is necessary to replace it every one to three years on account of wear.

The poor quality of present bridge timber, together with its advance in price, has led engineers to devise some form of light and yet durable reflooring material. Creosoted bridge plank has proved very economical on isolated bridges where traffic was light and wear was not considerable. Wear, however, is the most serious problem on the average highway bridge floor; hence, some form of treatment seemed necessary to prevent excessive wear on the wood.

In Illinois a number of old bridge floors have been replaced with creosoted subplank and then surface-treated with a bituminous material covered with stone chips or torpedo gravel. The bituminous mixture was maintained so as to resist the wear of traffic. It has been found that such bituminous surfaces can be kept in condition at less expense than the continual repairs and renewals that are necessary where ordinary plank flooring has been used.

The expense connected with securing creosoted bridge plank, together with the delays and inconvenience of applying the usual bituminous wearing surface, discouraged the average road official from placing such floors on the numerous short spans that are scattered in all parts of his district.

The writer has made several investigations with different materials and mixtures with an idea of finding a product that was low in first cost and that could be used by the average road official with little trouble. The

*Maintenance Engineer, Illinois State Highway Department, Springfield, Ill.

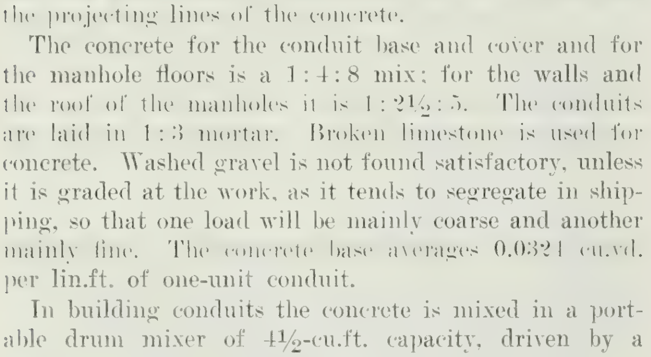


FIG. 1. SHOWING CONDITION OF OLD BRIDGE FLOOR PRIOR TO APPLYING BITUMINOUS MIXTURE

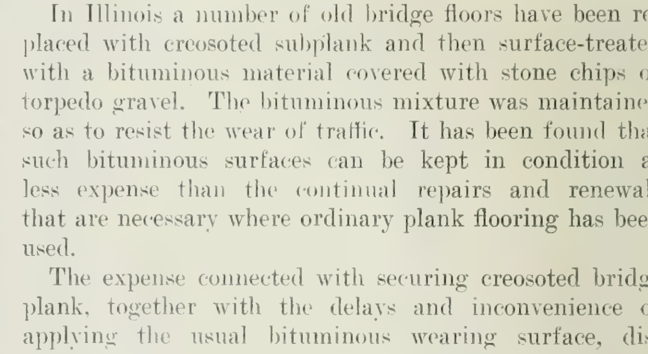


FIG. 2. SHOWING BITUMINOUS SURFACE ON OLD BRIDGE FLOOR AFTER SEVERAL MONTHS' SERVICE

material that has proved most successful is a mixture of stone chips (¾-in. down to dust, with the dust removed) and an emulsified asphalt that could readily be mixed with the aggregate without either being heated in special apparatus.

The advantages of the emulsified asphalt are that it can be used cold, can be thinned with water, can be used on a wet day, and will permit thorough cleaning of the plank with water prior to its application. The use of such a bituminous product insures a thorough coating of the aggregate and at the same time will not permit a surplus of the material that might cause creeping, bleeding or leakage through small cracks that may exist in the subflooring.

The dense mixture of stone chips and sand, becoming thoroughly coated with a film of asphalt, readily packs under traffic and forms a mat that resists in a measure the wear of traffic. It also waterproofs the surface so that, when properly maintained, it will ordinarily save the untreated floor from decay until some time in the future when the old bridge is replaced with a more permanent structure.

Applying the Bituminous Mixture

Bridge floors should have a crown of from 2 to 4 in.; the plank should be fitted as close together as possible, and all cracks should be filled with wood strips prior to the application of the bituminous mixture. The plank should be cleaned thoroughly with water. The mixture should be spread evenly over the entire surface to a thickness of 1 to 1½ in. The surface should then be sanded lightly and then tamped or rolled. Where tamping or rolling is not convenient, the surface should be watched carefully during the first few days to see that it is not displaced by traffic. It is not necessary to close the bridge to traffic while the mixture is being applied or during the time it is setting, which is an important factor in its favor.

The bituminous mixture should be made by mixing about 1 gal. of the emulsified asphalt with 1 cu.ft. of aggregate. The bituminous compound should be stirred thoroughly and in some cases a slight amount of water added to make it liquid before it is mixed with the aggregate. The materials may be mixed by machine or by hand until all stones are coated thoroughly before being applied on the floor.

Under ordinary conditions, such treatment can be applied at a cost of 25 to 30c. per sq.yd. including labor and materials, but excluding the bridge timbers. This is about one-half the cost of mastic surfaces where it is necessary to heat the bituminous material and build up a wearing surface by successive layers of bituminous material and stone chips or torpedo gravel; and about one-fourth as much as renewing the bridge floor with ordinary hardwood lumber. Such treatment may be used to great advantage in highway bridge work as it will reduce the maintenance cost and at the same time make old structures much more serviceable. The reduction of impact, by the smooth surface, compensates for the slight additional dead-load.

The foregoing experiment and investigation has been carried out for the Illinois State Highway Department, with the consent and authorization of William W. Marr, chief state highway engineer, and the author is maintenance engineer.

Filing the Records of City Engineer's Office at Los Angeles, Calif.

The filing of the city's engineering records in Los Angeles is fully explained by George H. Tilton, Jr., of the City Engineer's Office. The classification is as follows:

1. Records showing location are termed maps.
2. Records showing profiles are termed profiles.
3. Records showing detail are termed plans.
4. Fieldbooks, deeds, etc., are self-explanatory.

Mr. Tilton says: "The conglomeration of sizes is sorted into lengths and a series of numbers is allotted to each length in each classification, as follows:"

1 to 249 Roll maps 12 in. wide and under
250 to 1,999 Roll maps 12 to 18 in. wide.
2,000 to 3,999 Roll maps 18 to 24 in. wide.
4,000 to 5,499 Roll maps 24 to 36 in. wide.
5,500 to 5,999 Roll maps over 36 in. wide.
6,000 to 9,999 Flat maps of a uniform size.
10,000 to 10,249 Roll profiles 12 in. wide and under.
10,250 to 10,999 Roll profiles 12 to 18 in. wide.
11,000 to 14,999 Roll profiles 18 to 24 in. wide.
15,000 to 19,999 Flat profiles of a uniform size.
20,000 to 20,999 Roll plans 12 in. wide and under.
21,000 to 21,999 Roll plans 18 to 30 in. wide.
22,000 to 24,999 Roll plans 30 in. wide and over.
One up for fieldbooks, deedbooks, etc.

As soon as one of these series of numbers is exhausted the alphabetical prefix is assigned and the series re-run.

The actual indexing and numbering is now ready to be done rapidly and accurately. Each record is numbered with a stamp so that all numbering is of uniform size and in the same location on the record. Each classification is listed in a "list book" and indexed both in the "division index" and "alphabetical index" so that it can be found either by name or location, one of which it is necessary to know. In the division index the records are arranged according to year made.

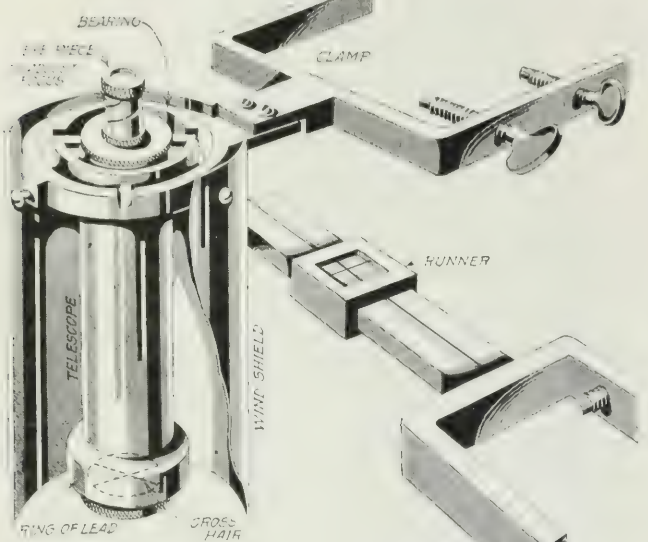
Sixteen years ago, when this system was inaugurated, the area of the city was 43.26 sq.mi.; today it is 337.92 sq.mi. This continued expansion has not impaired or confused the early records in any way, in fact an early record is found as quickly as a late one. To keep this system up to date and the records in place the entire services of one man have been found necessary.

FINE AGGREGATE

Transporting Large Oil Tanks by Scow was the method employed when the Point Wells, Wash., storage plant of the Standard Oil Co. (California) was recently enlarged. The receptacles weer taken from the plant at Seattle, 14 mi. from Point Wells. One scow carried two tanks 30x30 ft., two 16x20 ft. and one 16x16 ft., as illustrated. The largest tank, 90x30 ft., was loaded on two scows. The six receptacles have a combined capacity of 1,824,686 gal. The Olsen-Nicholson Co. was the contractor.

FIVE OIL TANKS TRAVEL 14 MI. BY SCOW

Plumbing Telescope Available for Building Work—The Pluckham plumbing telescope, recently developed, is intended as a substitute for and as a considerable improvement over the plumb line. Plumbing with this instrument is, of course, an operation independent of wind. The instrument consists of a telescope (18-power) fitted with crosshairs, suspended in a gimbal bearing to hang plumb. Oscillation is reduced by means of a heavy ring of lead at the bottom of the telescope. The instrument is fastened to the flange of a column by a clamp and can be fastened in the same manner to the corner of a building. A case protects it against wind. At the foot of the column is clamped a target graduated in inches, having a runner as on a slide-rule. In sighting through the telescope the intersection of the cross-hairs will be in line with the zero mark on the target when the column is plumb. Charles Pluckham, the inventor, is associated with Charles Bizozer, 526 W. 158 St., New York City. Mr.



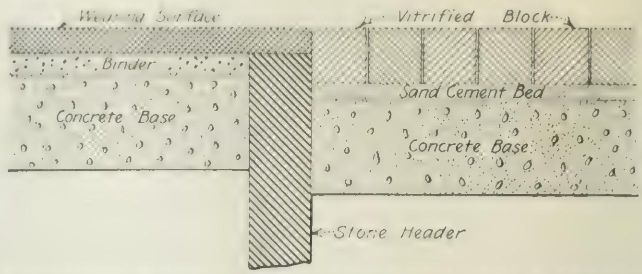
DETAILS OF THE PLUMBING TELESCOPE

Bizozer states that they are ready to manufacture and sell the instrument at a reasonable price. He says that one of these telescopes has been tried out by the George A. Just Co., of Brooklyn, N. Y. The details of the instrument are shown in the sketch.

Unusual Expansion Trouble in a Steel Bridge was met a few years ago in the case of an old street bridge in the Central States. Like many other old bridges, this one had been made to do duty as a street-railway bridge, though not designed for such service. After a time the bridge showed signs of weakness, and finally a bridge engineer was called in to report upon its safety. A long viaduct approach at one end made a fairly sharp turn near the beginning of the river bridge, and at this point, as the inspecting engineer found, one bent of the viaduct was strongly anchored by a heavy wire rope guy to a deadman on the inner side of the curve. The bent showed some outward distortion and the engineer was told that the anchorage was intended to keep the bent from tipping over. On examination it developed that the whole approach, about 600 ft. long back of the turn, was built solid, without expansion joints. Expansion had simply shoved the corner bent forward and outward. No special question was raised by this expansion trouble because the viaduct was found to be so badly corroded in its floor system as to require immediate stopping of traffic and prompt construction of a new bridge.

Marking Brown (Van Dyke) Prints White—In your issue of Dec. 14 Edward Godfrey gives a method which I have no doubt works well, but it necessitates keeping on hand a supply of hydrochloric acid and peroxide of hydrogen. For several years past I have used with perfect success a weak solution of corrosive sublimate. This may be conveniently made by dissolving a small tablet of bichloride of mercury (ordinary antiseptic tablets) in a small quantity of water and using this as ink, with pen or brush. A bottle of Bernay tablets (100) may be had at any drug store for 25c., and will keep indefinitely.—Henry E. Elrod, Interurban Building, Dallas, Tex.

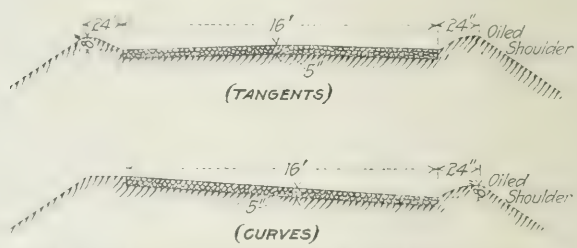
Sunken Stone Header Prevents Failures in Paving—Baltimore, Md., has adopted a detail of pavement construction to prevent failures at such points where a hard paving material like granite block, brick or wood block adjoins a softer material like asphalt. This detail is as follows: A well-jointed stone header, 12 in. or more in depth and 4 or 5 in. in width, is constructed across the street parallel to and 1½ in. below the finished cross-section. The concrete base is placed on one side of the header for the block pavement, and on the other side for the asphalt pavement. The blocks are laid tight



SUNKEN STONE HEADER PREVENTS FAILURES IN PAVING

against the header, which in case of a 3½-in. vitrified block gives a 2-in. bearing. When the asphalt is laid, the binder course is brought flush with the header; and the topping or wearing surface is laid over the header to the finished contour of the street, thus leaving the header 1½ in. below and entirely hidden from view.—Harry D. Williar, Jr., Assistant Engineer, Baltimore Paving Commission.

Oiled Road Shoulders solved the storm-water protection problem on a mountain road in San Bernardino County, California. This mountain road with a maximum grade of 5% presented a serious problem in the protection of high embankments from the wash of storm water running off the paved surface. The problem would have been simple if funds had been available for concrete curbs and gutters. Instead the following plan, illustrated in the accompanying cross-sections, was adopted: The shoulders for 2 ft. in width were raised from 6 to 8 in. by filling with the adjacent gravelly soil, and were rounded off to easy curves. The shoulders were then given two coats of 75% asphaltic oil, each coat being properly sanded. Cutouts for the water were provided



OILED ROAD SHOULDERS, SAN BERNARDINO COUNTY, CALIFORNIA

at safely placed points and at culverts. This method of construction formed an earth curb, and the pavement acted as the gutter. The oiled shoulders have a sufficiently hard surface to resist erosion and also serve to protect the edge of the macadam from breaking down under wheel traffic. There was a considerable saving over standard practice, the cost being only about 2½c. per lin.ft. of shoulder—J. S. Bright, Jr., Engineer, San Bernardino County Highway Commission, San Bernardino, Calif.

Durability Tests of Wood-Block Pavement—Inspection of an experimental piece of treated wood-block pavement, laid in 1906 by the City of Minneapolis in coöperation with the United States Forest Service and various lumber manufacturers and wood-preserving companies, has revealed the fact that white birch is wearing as well as longleaf pine, and that sapwood of timber if well treated is practically as durable as heartwood. Data thus far recorded and analyzed at the Forest Products Laboratory at Madison, Wis., indicate that in order of efficiency the six species used in the experiment rank as follows: (1) Longleaf pine and white birch; (2) Norway pine; (3) tamarack and eastern hemlock; and (4) Western larch. Douglas fir blocks were also included in the experiment, but were laid at a later date than the other species and no definite conclusions in regard to their relative durability can be drawn at this time. When this pavement was laid the traffic on it was principally steel-tired, horse-drawn trucks, with few motor vehicles. It is now mostly motor traffic.

Editorials

Progress in the Art of Tunneling

The adoption of the shield method for construction of a small tunnel in Milwaukee in fairly good ground is one of various recent occurrences that tell of progressive, original activity in the field of tunneling. It is a fact that tunnel construction is among those fields of civil engineering work where marked advance is being made.

Within the past month two compressed-air tunnels of great difficulty were holed through, the Old Slip tunnels under the East River at New York. Various elements contributed to the success, which in the aggregate mean distinct progress in the art. Rapid control of face work, deep and wide blanketing of the river floor, and a highly original void-filling method—"grouting" with gravel by air ejection—are the chief of these elements.

A few months back the completion of the Rogers Pass tunnel, a sound-rock tunnel, signalized the brilliant success of a radically novel method of attack in rock. The system of blasting in rings from a central pilot tunnel, a bold innovation, was the key to success. Though centuries of prior art in rock tunneling were available, sound engineering in this case lay in abandonment of precedent.

Precedent was cast aside similarly in the new Cleveland intake tunnel under Lake Erie, which also was holed through a few weeks ago. The stereotyped form of lining for shield tunnels—cast-iron segments—was dropped, and a lining of concrete blocks was substituted. The economy of this expedient is obvious, iron being costly. But whether a long tunnel, with all its contingencies and hazards, could be built of concrete blocks in successful manner had to be proved by experience.

With new activity thus moving in the field of tunneling, further development is sure to result. As tunnel construction is cheapened and its range of application widened, it will be more frequently applied.

Good Business Methods in Enlarging the Engineering Societies' Building

Even more interesting than the technical features in the work of adding two stories to the Engineering Societies' building, described in this issue, was the skill with which the undertaking was piloted through some critical stages. While the negotiations between the several societies were going on, the New York City authorities announced the early enactment of an ordinance limiting the height of buildings which would have made the projected addition to the building to accommodate the American Society of Civil Engineers impossible. In order to save the day it was necessary to prepare plans and file them with the Bureau of Buildings before the passage of the new ordinance. This required a considerable outlay of money for the preparation of plans, at a time when it was uncertain whether the Civil Engineers' membership might not reject the proposition. The society's letter ballot could not be taken and canvassed early enough to permit the plans to be prepared and filed after the vote was counted. Under these circumstances the leaders in the conference showed their faith in the project by ordering the plans prepared and filed at once. The outcome of the Civil Engineers' vote abundantly justified their courage.

At a later stage, the steadily rising prices of materials created another situation in which quick decision was required before all the formalities of voting on contracts could be complied with. Bids for the major part of the work were obtained that called for immediate acceptance to forestall a very considerable rise in price. Again the officials in charge of the work seized the opportunity and made a prompt decision—accepting the contract without waiting on red tape.

The efficient handling of this engineering society enterprise is a matter for general commendation. It proves that even the involved routine of society management can be bent when necessary to meet the exigencies of urgent business matters.

Already it has become practically certain that the cost of adding the three stories will exceed the advance estimates, because of the skyrocketing of prices. With only a little more deliberation in handling the job, however, the increase would have been much greater. As it is, the work will go through without financial strain on any of the interested societies.

Army Engineer Corps Commissions for Recent Technical-School Graduates

A special effort is being made this year to interest young, qualified engineers to take the coming examination for appointment as probationary second lieutenant in the Corps of Engineers, United States Army. Up to now it has been required that candidates for appointment must not only pass an examination, mental and physical, to enter which they had to be between 21 and 29, unmarried and a graduate of an approved technical school, but that they also have the preliminary qualification of being eligible for appointment as Junior Engineer in the Engineer Department at large, which itself was attained only by examination.

For the examination to be given next summer, Gen. W. M. Black, Chief of Engineers, has recommended to the Secretary of War that the Junior Engineer requirement be waived. The candidates, therefore, will not be under the necessity of taking two examinations, and it is probable that practical engineering experience will not be considered so essential in the one examination as it has hitherto in the first of the two examinations prescribed. General Black calls attention to the fact that the five young men recently commissioned in the corps, brief statements of whose careers were given in last week's *Engineering News*, have not had extensive engineering experience and adds:

This is as it should be, for the reason that the best material for officers comes from the very recent graduates

of technical schools, men who are still young enough to undergo further instruction in the special duties which fall upon the Corps of Engineers and which are not provided for by the training received in technical schools. For the best results, officers of Engineers should start their service early in life, and every inducement is being extended to the recent graduates of technical schools to become candidates for appointment in the Corps of Engineers. Every effort is being made, through the kind coöperation of the faculties of some of the leading technical schools, to insure that the examination shall be entirely reasonable, so that a well-qualified candidate will be successful.

The opportunity for young engineers to secure responsible and honorable positions and at the same time to serve their country seems brighter than ever before. It is to be hoped that many of the large body of those qualified will present themselves for examination. Particulars can be ascertained from the office of the Chief of Engineers, United States Army, Washington, D. C.

Concreting à la Mode

The day after Christmas a pedestrian hurrying up Broadway over the timbering that for many months has served as temporary subway roof and sidewalk pavement might have had his attention arrested by a pile of concrete—the size of a dumped two-ton load of coal—fully mixed but dry, occupying most of the curb half of the sidewalk. The temperature, by official record since obtained, was 31° F. in the shade, and the December sun was not doing much to raise the mercury. Laborers were shoveling this mixture into barrows and were wheeling them to a near-by hole leading into the unknown depths of the subway structure. At the top of the hole a foreman, by dress and address, was controlling the business end of a hose reaching from a city-hydrant connection. From this hose he merrily played a good-sized stream into the half-turned barrow and the dry mixture was forced by sheer weight of the water piled up behind it to slide out and into the chute. At the end of the load some vigorous hydraulicking dug out the gobs of dry mix clinging to the corners of the barrow, at the same time dumping a few extra gallons of water down the chute.

That is all, except that the Broadway subway is being built by a well-paid expert contractor under the direction of high-salaried expert engineers and that at times one wearies of printing and preaching the elements of good practice in mixing and placing concrete.

Boston Rebuked for Unjust Treatment of Its Engineers

A severe condemnation of the present administration of the City of Boston and its treatment of its engineering staff is contained in a recent report of the National Board of Fire Underwriters:

The organization of the Metropolitan Water and Sewerage Board is excellent, and the officials are competent. In the City Water Department the recent discharge of employees for reasons other than lack of fitness for their positions cannot fail to have an effect on the morale of the department and the willingness of competent and progressive men to enter its service.

This condition of affairs has not failed to have its effect and is directly responsible for the incomplete and deplorable status of the high-pressure fire-service system, described in a special report of the Board of Fire Underwriters, an abstract of which appears elsewhere in this issue. This report has, fortunately, received wide publicity in Boston, and because of its source and importance it is sure to receive the careful consideration of the city's merchants, property owners and substantial business men; let it be hoped that the effect will prove beneficial.

About a year ago the honorable mayor of Boston "fired" 17 members of the staff of the Department of Public Works on 18 hours' notice, because they had not been active in reëlecting him, and notwithstanding that all were nominally under civil service and had been in the employ of the city from 7 to 41 years. The way for this action had been prepared long before by letting go the efficient engineer-commissioner of the department and substituting a politician. Some of the decapitated employees were reinstated, three by orders of the courts to which they had appealed. But the damage done is irreparable, so long as Mayor Curley remains in office.

Nor is it the Department of Public Works only which is suffering. The report of the National Board of Fire Underwriters, above quoted, states further that the Boston Fire Department, which formerly ranked among the most efficient, has failed to maintain its previous standing, although appropriations have been liberal. Inside intrigues, aided by outside politicians, are tending to destroy its discipline and efficiency.

In the meantime, with its high-pressure fire-service installation incompleted and dragging along, and the Fire Department losing its efficiency, the City of Boston faces a conflagration hazard which only those familiar with the congested parts of that city can fully appreciate. Such conditions in a city of the wealth and standing of Boston are intolerable; and it ought not to require a conflagration or an earthquake to bring about a reform.

Saving the Horseshoe Fall at Niagara

By the terms of an international agreement between Canada and the United States the former country may divert from the Niagara River 36,000 cu.ft. per sec. for the development of hydraulic power, while the United States on its side may divert 20,000 cu.ft. per sec. for the same purpose. Congress has hitherto permitted the diversion of only 15,600 cu.ft. per sec. on the American side, but an emergency created through the diversion for Canadian use of current hitherto sent across into the United States has caused the introduction in Congress and passage by the Senate of a resolution permitting the companies on the American side to divert 4400 cu.ft. additional for power development.

This permit in only temporary, terminating on July 1, but it has excited the alarm of the guardians of Niagara. A call to rally all forces to defeat the measure is sent out by E. H. Hall, Secretary of the American Scenic and Historic Preservation Society. In a letter published in the New York *Times*, Jan. 3, Mr. Hall says:

The friends of Niagara who do not wish to see the cataract's beauty further impaired should send their remonstrances at once to their Congressmen and later, if necessary, to the President, if the effect of this so-called temporary measure and the more permanent measure for which it paves the way are to be averted.

Figures furnished to the American Scenic and Historic Preservation Society by United States engineers indicate that increased diversion of the water on the Canadian side in the years 1912-1916 lowered the water on the west end of the Horseshoe Fall more than a quarter of a foot, or to be exact, 0.26745 ft. Heaton's "Annual" for 1915, a Canadian

publication, states that the crest of the Canadian fall has been shortened 550 ft. since 1900. . . . It is evident that Niagara is in a precarious condition.

It is one thing to make measurements of water level accurate to 0.00001 of a foot; it is another and quite different thing to interpret correctly the physical causes that have produced the changes of which the measurements of water level are the index. The secretary of the Scenic and Historic Preservation Society *assumes* that the lowering of the water on the sides of the Horseshoe Fall is due to the increased diversion of water for power purposes on the Canadian side. In *Engineering News* of Dec. 14, 1916, however, John L. Harper, a well-known engineer, presented very convincing testimony indicating that the lessening of flow at the sides of the Horseshoe Fall is not due to the diversion of water from the river for power purposes, but to the rapid deepening of the river channel at the toe of the horseshoe by the vast volume of water now concentrated there. Elsewhere in the present issue of *Engineering News*, Isham Randolph, of Chicago, adds his testimony to confirm the soundness of Mr. Harper's diagnosis.

Even without the testimony of these well-known engineers it is easy for even an amateur in hydraulic engineering to see that there is something defective in Mr. Hall's assumption above quoted. The crest of the Horseshoe Fall is nearly 3000 ft. in length. It is true that diversion of water for power purposes on the Canadian side would not affect the depth equally over the entire length of the crest. The power-house intakes are far enough above the falls, however, so that increased diversion would certainly affect the depth a long way around the horseshoe. It seems very unlikely that increased use of water by the power plants on the Canadian side during the past four years while no new plants have been built can have diverted a volume of water so great as to account for the reduction of depth at the west end of the Horseshoe Fall which Mr. Hall states. It is entirely reasonable to believe, on the other hand, that the deepening of the river by the rapid erosion at the toe of the horseshoe, which is proceeding at an accelerating rate, is sufficient to account for a large part of the reduction in depth at the sides of the Horseshoe Fall.

The idea is too commonly held that the engineer is a materialist, interested solely in the utilitarian side of industry and having no appreciation of the beautiful in art and nature. It is our belief, on the contrary, that there is no body of men more generally appreciative of the beauty of landscapes and more generally interested in the preservation of natural scenery than are civil engineers. It is one of the compensations of the civil engineering profession to many of its followers that it gives them opportunity for outdoor life and the privilege of enjoying natural scenery to an extent impossible for a worker in an office or a shop. Mr. Hall will find a great number of engineers in hearty accord with his society, that the great cataract at Niagara must be preserved as a scenic spectacle. These engineers also realize, however, that this demand must be harmonized with the equally legitimate demand that the surplus power of the cataract shall be developed for public service. It is as important that men shall have the necessaries of life as that they shall be able to enjoy the beauties of nature, and enjoyment of the latter is impossible without the former.

The American Scenic and Historic Preservation Society has undertaken to protect Niagara Falls from destruction, but it can best accomplish this if it assumes a constructive instead of an obstructive attitude. The preservation of Niagara Falls as a grand world spectacle is a worthy object; but it is surely worth while to ascertain without prejudice the means by which that object can best be obtained, instead of concentrating every effort on opposition to the utilization of water from the falls, regardless of the extent to which such utilization may be responsible for changes in the cataract.

Hope for a Reform in the Conduct of Federal Public Works

"Sweet are the uses of adversity." So long as the national treasury was filled to overflowing and there was no fear of a deficit, engineers and others have urged in vain that the criminal waste of public money on worthless river and harbor projects should be stopped, and that a properly qualified commission should so control the expenditure and distribution of money for public works that the money would be spent only where the benefit to commerce justified it.

Again and again has this common sense and businesslike method of dealing with our public works been advocated, in the halls of Congress and elsewhere; but the talk has vanished into thin air, and congressmen with importunate constituents to take care of have portioned out the river and harbor expenditures and the public building prizes in such a manner as their political power permitted.

This year, however, it is reported from Washington that President Wilson has served notice in advance on the congressional advocates of the $35,000,000 Public Buildings Bill and the $40,000,000 River and Harbor Bill that these omnibus distributions of pork shall not be made at this session if his veto can prevent it. Furthermore, he is reported to have declared that whatever money is to be spent on river and harbor work at a time when the Government faces an enormous deficit, must be spent on the recommendation of a competent commission which will deal with the matter from the national point of view and not from the local. If these reports prove true, and if the impending deficit actually brings about the establishment of businesslike methods in dealing with Federal public works, the deficit will be a profitable experience for the nation.

Another Valuable Concrete Fire Report

The Edison fire of two years ago was a highly educational catastrophe because of the thoroughness with which various technical bodies investigated the behavior of the reinforced-concrete buildings under such extreme heat conditions. Similar good results will flow from the warehouse fire of last November at Far Rockaway if wide distribution is assured of Mr. Woolson's admirable report of that structure, noted on another page of this issue. The Rockaway fire was decidely ominous in many ways. Respectful consideration of its lessons is imperative.

Letters to the Editor

Really Good New Year's Resolutions

Sir—It does not pay to make too many of them, but there are a few resolutions, which to make and keep, will do any of us a whole lot of good. So I do promise and swear: That I will read my copies of "Engineering News" within 24 hours after I get them. Furthermore, I am going to make it a point to look through the advertisements as carefully as through the reading matter, because I know there is a lot of "meat" there that is missed by most of us. One more, and I am through, for the fewer the resolutions, the more apt they are to be kept. Our stock in trade is knowledge. New books contain uptodate knowledge. So it is agreed to, by and with myself, that I will buy three new books every year. I have never spent money for books that I did not feel I had got my money's worth.

"MAKE A FEW RESOLUTIONS."

Albany, N. Y., Jan. 1, 1917.

Experiences of an "Examiner"

Sir—The comments of C. S. Merit in "Engineering News" Nov. 23, 1915, concerning the announcement by a civil service commission of an examination to fill the position of Civil Service Examiner in mechanical engineering, recalls this little poem from an old zoölogy:

The little fleas have smaller fleas
To worry 'em and bite 'em.
The smaller fleas have lesser fleas,
And so ad infinitum.

I am too firm a believer in civil service principles to hold it up to ridicule, yet no one can fail to see its serious shortcomings. As to passing examinations being the chief end of man, do we not meet every day men who are confirmed and habitual takers of examinations? I have come near to being in that class myself, but I believe that I have finally successfully sworn off. I have taken a great many United States examinations and one state examination and passed them all. In one case I was second on the list and there were to be three appointments. I have never heard from any of these examinations other than to receive my ratings and to know that I had passed and stood well up in the list. Although I am now a civil service employee, I was appointed prior to the passing of the civil service law and was confirmed without examination.

Civil service somewhat resembles socialism and single tax, in being a fine theory which no one has yet found a way to employ successfully in practice. C. S. VETERAN.

San Francisco, Calif., Dec. 8, 1916.

Protecting Automobile Traffic at Railway Grade Crossings

Sir—In "Engineering News" of Dec. 21 there are illustrated and described a number of plans suggested by the Railroad Commission of California to compel automobile traffic to slow up when passing over grade crossings so that proper caution may be exercised.

Permit me to suggest that a simpler and more effectual plan than any of those described is the placing of a hump in the roadway on each side of the crossing and 50 ft. or so distant. The hump should have a rounded contour and be of such a height and curvature that a car moving at low speed, six to eight miles an hour, will pass smoothly over it, but the automobilist who attempts to speed across it at 20 miles an hour or more will be taught a severe lesson. A gutter transverse to the roadway would serve of course as well as a hump, but would introduce difficulties in drainage, and cars would occasionally be stalled in it. There should, of course, be a prominent "slow" sign warning drivers not only of the crossing, but of the hump.

There has been much complaint in the last year or two of speeding motors breaking down guard gates at railway crossings. I suggest that an effectual cure for this practice of the speed maniac is the suspension from each gate of a strip of heavy canvas which, when the gate is down, will lie flat on the road. The canvas should be well studded with sharp brads projecting through it from the bottom side with their points up. If a still more savage punishment is wanted, attach a bar to the gate at such a height that it will strike the wind shield if the car runs into the gate when it is down. It might be objected that such an appliance would be too dangerous to install. This is probably true at a crossing as ordinarily arranged. If, however, an effective hump as above suggested is placed back of the crossing, the compulsory slowing up will make it certain that the driver who runs into the gate when it is down does so intentionally.

New York, Dec. 27, 1916. "SAFETY FIRST."

[In the article mentioned, it was stated that the grade check submitted by J. H. Weatherford, City Engineer of Memphis, Tenn., was a soft or retarding pavement on each side of the track. Mr. Weatherford advises us that what he recommended was to place a ridge or bump across the roadway, about 50 ft. from the tracks, exactly as recommended by "Safety First" above. The scheme has been used at grade crossings in the City Park roads at Memphis and has been tried at Los Angeles, as described in "Engineering News" of Sept. 7, p. 462.—Editor.]

Unwise Duplication of Transportation Facilities

Sir—In the midst of so much discussion concerning highway building and improvement, would it not be well to consider the relation improved highways may sustain to other facilities for transportation that may be already in existence?

Highway building and improvement will doubtless receive a decided stimulus by the recent action of Congress for coöperation between Federal and state authorities and through the spending of the $75,000,000 of Federal aid funds. Recognizing the beneficient influence of good roads upon the life of a community, I would be the last to hinder in any manner road improvement, but rather I would promote such enterprise by every legitimate means. However, attendance at a typical good-roads meeting of the local sort leads me to believe that those most strenuously urging promiscuous hard-road building are persons whose taxable property consists chiefly of an automobile. In fact, comparatively little attention appears to be devoted at such meetings to the consideration of the general community benefit.

To be most effective road improvement should be made after some comprehensive scheme. The plan most commonly suggested at present is that of trunk-line roads between large cities. This arrangement is intended primarily to accommodate pleasure driving and, it is said, freight hauling with motor trucks. A recent discussion in the technical press came to the writer's notice concerning the probable truck loads for which highways should be designed.

Is this an economical and effective procedure? The public already, by the payment of railroad rates, have built, at an enormous expense, facilities in the form of railroads for transporting passengers and freight between practically all cities of size in the country, and it is proposed to duplicate these transportation facilities by building highways at public expense that will conduct transportation in competition with them.

In a sense, the public is thus entering into competition with itself by constructing a second plant for performing the same service. Moreover, such a scheme accommodates the needs of a relatively small proportion of the population. It has been demonstrated by several writers recently that automobiles cannot conduct transportation as cheaply as can the railroad, even though their track (the highway) is furnished free. Even if they might do so by virtue of improved equipment and methods, rates or tolls charged the users of such proposed trunk line highways to cover the cost of road maintenance would be entirely logical.

Now would it not be a more rational procedure to build the highways as supplementary to the railways in the general scheme of transportation instead of spending public money

in paralleling them? The railways (steam and electric) together with the highways should constitute one great commercial circulatory system of the country, the railroads serving as the main arteries and veins and the highways as the capillaries, the latter distributing the passengers and commodities to their ultimate destinations.

The cost of transportation from consignor to consignee is dependent upon local haulage charges as well as upon freight rates, and funds might well be spent with a view to lowering the cost of local transportation in order that the entire cost of carriage may be a minimum. In other words, the highways should be planned primarily to care for local transportation, leaving to the railroads the trunk-line service between large centers of population.

Instead, therefore, of building the highways as competitors of the railways, they should be correlated with the railways in order that the whole may constitute a scientifically designed transportation system that will serve the general needs of the public most economically and most effectively.

C. C. WILLIAMS,
Professor of Railway Engineering and in charge of Highway Engineering, University of Kansas.

Lawrence, Kan., Dec. 21, 1916.

How To Save Horseshoe Fall at Niagara

Sir—In your issue of Dec. 14 is an article under the caption, "How To Save the Horseshoe Fall at Niagara," which was prompted by a paper of which John Lyell Harper is the author.

The subject discussed is one that has interested me for a long time past, as I have been familiar with the conditions at the falls for many years. For several years I was retained by the Queen Victoria Niagara Falls Park Commission as consulting engineer. I also acted in an advisory capacity for two of the power companies on the Canadian side and reported for the government of Ontario on the power situation at the falls and upon the possibilities of further development of power, both at the falls and from the rapids below.

During this long period of observation I have seen the Horseshoe Fall undergoing a transformation, gradually losing its U-shape and approaching a V-shape. I have seen the discharge over the limbs of this V lessening in depth and the descending sheet of water becoming more and more diaphanous while the torrent at the apex of the V became deeper, more voluminous and more destructive in its onrush to the abyss below.

I have seen this and realized that, unless something is done to arrest this destructive force, the beauty of the fall will deteriorate and the recession of the escarpment proceed with ever increasing rapidity.

I saw the importance, I might say the necessity, of diffusion works, and I evolved the method and the mechanical means of accomplishing the desired result.

When Mr. Taft was returning from Panama in February, 1909, aboard the armored cruiser "North Carolina," accompanied by the engineers of the commission which had gone with him to the Isthmus, I, as a member of that commission, had the privilege of daily intercourse with the then President-elect; and during that time I told him of conditions at the falls and of the remedy which I believed would arrest the destructive agencies that were at work. He was much interested and proffered his aid in bringing my plans before the Dominion Government.

I did not call upon him to make his offer good until 1911. Then he gave me a strong letter to the Minister of Finance, Mr. Fielding. This letter I presented to the Minister in Ottawa on Feb. 13, 1911. Mr. Fielding, after reading the letter, said: "My first question is, Is there any money in it for Canada?" I replied that there was, for by carrying out my plans the beauty of the falls would be preserved and a great volume of water now running to waste without producing beauty could be diverted from the falls—without detracting from either their grandeur or their beauty—and made to produce power.

He said that it was a question which really did not come within his province and gave me a letter to Dr. Pugsley, Minister of Public Works. When I laid my project before him, Dr. Pugsley sent for his engineering advisors, Louis Coste and A. St. Laurent, and instructed them to go fully into the subject with me and to report their conclusions to him. These gentlemen went fully into my plans with me and reported to the Minister of Public Works, whether verbally or in writing I do not know; but they both told me that their report was favorable.

Shortly after that the Laurier party was defeated, and the Borden party came into power. Since then I have made no effort to push my plans. They can only be carried through by coöperation between the Canadian Government and our own. Could they be carried out, the discharge over the whole rim of the falls could be made of a depth to produce the most beautiful effect; and the torrent which, unchecked—to borrow a simile from Mr. Harper—is so suicidal, would be diffused and rendered innocuous.

ISHAM RANDOLPH.

Continental Bank Building, Chicago, Ill., Dec. 27, 1916.

Sir—"Engineering News" of Dec. 14, 1916, p. 1135, contains an explanation of the apparent diminution of flow, with consequent lessening of the grandeur, of the Horseshoe Fall at Niagara. The author of the article suggests an "invisible" island to divert the main stream of water away from the narrow gorge that has been forming at the brink of the falls for several years.

This same idea has appealed to me, except that I should prefer a real island, not only visible, but accessible. To create such an island, I suggest a gang of cableways, say about four, from Goat Island to a point near the large gatehouse on the Canadian shore about opposite the extreme upper end of Goat Island. Judging from the appearance of the rapids, the bottom of the river under these cables would be found to contain many large holes, or pockets, and I should try to drop into one of these holes one or more blocks of reinforced concrete. These might be made large enough to project above the water. They could be made very heavy by mixing scrap iron or iron ore in the aggregate, and this with the hold in the pocket would prevent them from being carried over the falls.

With this block or pile of blocks as a sort of breakwater, I should then sink a small casing in the more quiet water downstream therefrom and work to right and left, always downstream and to a predetermined outline, with casings, filling them with concrete and vertical rods. These casings should be comparatively small, say 12-in. pipes, sunk by well drills.

They should be sunk as close as possible along the outline of the island, and about twice that distance apart inside, over the entire area of the island. The island itself should be of solid concrete up to low-water level and treated, as to borders at least, with local stone above that level. A competent landscape architect could complete the island with soil, trees, etc.

The crux of the whole scheme would be the placing of the original breakwater, strong enough and heavy enough to withstand the terrific and continuous hammering of the rapids. It should of course be located at a point carefully selected to minimize the action of the water as much as possible. There are high points in the river bed, with pockets above and below, in which the energy of the water in the immediate vicinity is largely spent.

Conceivably, a barge could be designed which would approximately fit some particular hole in the river bed and which, when suitably anchored to the United States and the Dominion of Canada, could be filled from the cableway, even with pig lead, until even the Niagara River would not have enough grip on it to move it over the edge of the pocket selected.

The author of the previous article points out the desirability of this improvement on nature. Herein is submitted a suggestion as to its feasibility. There remains now the problem of finding someone to finance the job and of obtaining the consent of the Canadians and our own War Department to the obstruction of the river. Then the island may become a part of the world-famous scenery at Niagara Falls. There are many lighthouses, on remote and dangerous headlands and reefs, subject to fully as heavy a bombardment of water as this island would be, and nothing of the sort is impossible if it is determined to be worth the price.

IRA DYE.

76 Broad St., Newark, N. J., Dec. 18, 1916.

NOTES AND QUERIES

The Address of W. R. Rutledge (an electrical engineer who lived in Frankford, Canada, about 1906, but who left for work in the United States) is desired by Rinaldo McConnell, Kent Building, 156 Yonge St., Toronto.

Concrete Arch Bridge at Minneapolis—In the article describing the progress of work on the reinforced-concrete arch bridge over the Mississippi at Minneapolis, published in "Engineering News," Dec. 21, 1916, p. 1201, credit for the detail design of the structure should have been awarded to the Concrete Steel Engineering Co., of New York City.

Quartz-Gravel Aggregate Main Cause of Fire Damage to Concrete Building

The fire in the reinforced-concrete warehouse of Mullen & Buckley at Far Rockaway, N. Y., on Nov. 10, 1916, reported in *Engineering News*, Nov. 16, 1916, p. 936, was very important because of the curious distribution of the fire damage and of the serious destruction of the concrete under fire conditions of comparatively minor intensity. As pointed out in the article referred to, the spalling of the concrete in some sections was very great and in one end of one floor the concrete destruction had been so complete in certain members as to cause failure. That report was written only three days after the fire, when access to certain parts of the building was impossible. Since then an investigation of the structure has been made by Ira H. Woolson, Consulting Engineer to the Committee on Construction of Buildings of the National Board of Fire Underwriters, and his findings have been embodied in a report just issued. This report confirms most of the conclusions of the *Engineering News* report, but owing to greater facilities and time for observation, the Woolson report shows that structural failure was more widespread than was first thought. The report emphasizes the importance of the fire to those interested in the fire resistance of concrete buildings, points out some structural and fireproofing truths that are obvious from the fire and finally condemns the quartz-gravel aggregate as the secondary destructive agency in the concrete under fire.

Mr. Woolson specifies the fire damage and traces the probable entrance of the fire on each floor. Strangely enough the transmission from the initial fire next door to the first floor was probably through a 5-in. hole in the concrete wall, a hole used for a carrier system passage. In the ceiling above this hole was a 4-in. hole apparently left by the removal of a heating pipe. Through these two holes, through ½-in. openings alongside a poorly fitting fire-door, and through a 1-in. hole left from construction, the fire apparently spread from floor to floor, although even now there seems to be a possibility that one of the fire-doors separating the concrete building from the adjacent wood building where the fire started had been left open.

In structural damage, Mr. Woolson found considerable repetition of damage reported in the *Engineering News* article. All of this damage, however, is of like nature, that is the serious spalling of the concrete covering the reinforcement with consequent deflection or failure from structural weakness. The main conclusions of the report are as follows:

1. The one fact which stands out above all others in connection with this fire is that a suitable sprinkler system would have saved the concrete building with its contents and probably have controlled the fire in the frame building. It is one more demonstration of the folly of depending upon fire-resistive construction alone to protect inflammable contents of a building from fire. The owners had evidently made sincere effort to have a very safe structure. It was in general well built; wired glass windows were provided on all sides; the protection of vertical openings were standard; double approved fire doors were provided on communicating doorways; sets of fire pails properly filled were scattered about each floor, but were useless because of the smoke which entered the building preceding the fire. With all these precautions the building is today badly wrecked; a large proportion of the contents are ruined either by fire or water, and a total property loss of $125,000 or more has been sustained. Only a portion of this is covered by insurance and the business of the owners will be more or less paralyzed for many months. All this could have been saved by a comparatively small investment in sprinkler protection.

2. Although the area was not excessive, nevertheless it is quite apparent that had the floor space been divided by partitions of even moderate fire-resistive capacity the fire would have been localized and a large proportion of the damage prevented. In two stories—the fourth and seventh—plain pine board partitions held the fire from spreading until firemen were able to extinguish it.

3. The folly of erecting a high-grade fire-resistive building in all essential structural features and then allowing its efficiency to be ruined by permitting unprotected openings, even of small size, in walls and floors was strongly emphasized. The fact that fire was distributed from story to story by 3- and 4-in. pipe holes and that in at least one instance it was transmitted through a 1-in. hole in a fire wall indicates the extreme care and ferret-like inquisitiveness which insurance inspectors must exercise if they furnish their companies with complete and reliable estimates of the fire hazards which exist in a building.

DAMAGE VERY GREAT FOR APPARENT FIRE

4. So far as the reinforced-concrete building itself is concerned, the most impressive feature of its appearance is the extent of the damage done, which seems to be quite disproportionate to the severity of the fire. With the exception of the exterior south wall, exposed to the adjoining burning building, and a portion of the third story, where a few barrels of oil and other inflammable liquids were burned, there were no indications of very hot or long-continued fire. In the areas covered by the two exceptions all combustible material was consumed, and there is evidence of fairly high temperature, probably 2000° F. In all other places where fires occurred, it is plainly to be seen that they were flash surface fires of short duration. They were extinguished before attacking surrounding material, and yet the damage to the concrete was severe.

5. The Edison plant fire, and fires elsewhere in reinforced-concrete structures, have taught us that the rapid surface expansion of concrete when subjected to a quick fire is destructive to structural members with sharp corners. Square columns and beams should, therefore, be avoided. Inspection of the photographs will show that the columns and girders in this building were beveled, but it was not enough to be of real service. This is another important lesson emphasized by this fire. Only round columns, or those closely approaching that shape, should be used on the interior of a building.

BEAM REINFORCEMENT SHOULD BE PROTECTED

6. The safety of beams is scarcely less vital than columns, but it is difficult to round them sufficiently to avoid spalling and at the same time properly protect the reinforcing bars. This difficulty can be overcome by using some form of mesh reinforcement surrounding the main reinforcement bars on the bottom and supported by them, similar to the methods employed to hold concrete fireproofing on steel I-beams. The added cost would be slight and the increased security when attacked by fire would be very material. Perhaps the best solution of the problem may be found in the elimination of beams entirely and using flat-slab construction. Unfortunately this form of construction is comparatively new, and we have not as yet secured sufficient testimony regarding its behavior when attacked by fire to judge its merits as a fire-resistant as compared with the older forms of construction.

7. A certain amount of the damage which ensued in this building can justly be credited to improper shape of structural members, and doubtless some of it may be explained by the fact that water was thrown upon the concrete while hot. The deficient concrete protection to the reinforcement probably also contributed to the failure; however, considering the freedom with which the concrete spalled from the reinforcement bars, it is questionable whether a thicker protection of this concrete would have rendered more efficient service. This excessive spalling seems inconsistent with what past performance has taught us to expect, especially when we consider the moderate fire which produced it, and we are extremely loath to believe that all concrete would exhibit the same weakness under like conditions.

The concrete itself appears to be good. Where not disintegrated by heat it is clean and dense. What then was the trouble? In the writer's opinion it was the use of quartz gravel for the coarse aggregate.

During the years 1905, 1906 and 1907 the writer conducted an "Investigation of the Thermal Conductivity of Concrete Mixtures, and the Effect of Heat Upon Their Strength and Elastic Properties." This work was done for the American Society for Testing Materials, and the final report was pub-

lished in the Society Proceedings for 1907. In this he said:

Although the thermal conductivity of the gravel concrete was fully as low as that of the trap, it must nevertheless be condemned as a first-class fire-resisting mixture. All the specimens of gravel concrete tested were badly disintegrated by the heat. The gravel specimens would crack and crumble in pieces when the trap and cinder specimens under similar treatment would remain firm and compact. The writer is convinced that concrete made from this particular gravel is not reliable as a fire-resisting material. Whether other grades of gravel would give equally unsatisfactory results is a matter for investigation.

The cause for this failure of the quartz mixture is not easy to locate. The most plasible reason seems to be the relatively large coefficient of expansion of the quartz. It is about twice that of feldspar, which is one of the predominant minerals in trap rock. Clark's "Constants of Nature," published by the Smithsonian Institution, gives the cubical coefficient of expansion for these minerals as follows:

Quartz .... 0.000036 Feldspar 0.000017

According to the same authority, quartz has another peculiarity of expansion, namely, that the expansion in the direction of the major axis is only half that in the direction of the axis perpendicular to the major axis. This unequal expansion may further contribute to its tendency to disintegrate the concrete under action of heat.

Since the distribution of gravel is much more general than trap, the subject is of much importance, and tests should be made to determine if other gravels are equally defective.

Also one of the conclusions in the "Summary" of that report was "That the gravel concrete was not a reliable or safe fire-resisting aggregate."

The behavior of the concrete in this fire appears to confirm the criticism above mentioned.

If this explanation is correct, as evidence thus far produced seems to sanction, all concrete specifications should contain a definite warning against the use of quartz gravel in concrete liable to be exposed to high heat. Where it is so used, underwriters should take that fact into account when assuming the risk.

WHY QUARTZ-GRAVEL IS POOR AGGREGATE

It should be stated that the weakness of quartz-gravel concrete is due to a general disintegration of the mass, and not, as might be supposed, to fracture of the pebbles themselves. Very few broken pebbles are found in such ruptured concrete. Quartz pebbles are usually made up of a mass of interlocking crystals, and although the unequal expansion of these crystals along their axes is microscopical in character, it can easily be conceived that each pebble when highly heated would be subject to numerous unbalanced internal expansion stresses tending to produce an agitation of the surface of the pebble which would contribute to breaking the bond between the pebble and the mortar in which it was embedded. Some evidence produced seems to indicate this, but the extent of such action is of course purely speculative. It may be found that the smooth surface of the gravel is the principal cause of weakness, though some tests upon concrete made of gravel other than quartz would not imply this.

Whatever the deteriorating cause or causes may be, it is quite certain that evidence thus far at hand is prejudicial to quartz-gravel concrete liable to be subject to fire. The matter is one of great importance to the concrete industry, and a complete investigation of the problems involved should be made by some qualified scientific authority.

Boston's High-Pressure Fire Service an Example of Municipal Inefficiency

Over five years have elapsed since the work of designing the Boston high-pressure fire-service system was undertaken, and from conservative estimates it will be two years more before a very necessary pumping station can be put into service, says the report recently issued by the National Board of Fire Underwriters. Because of delays, changes of plan, indecision and inefficiency on the part of the city administration, engineering expenses will be about double those customarily found in such enterprises. The report states:

Contracts have not been favorable to the city and have been poorly and expensively carried out. The continued delay and changing of plans have resulted in materially increasing the cost of the work which now has to be done to complete the system. With the low prices of labor and materials prevailing between 1911 and 1914, it is believed that the originally planned system could have been completed within the appropriation, but under the present conditions this is obviously impossible. Because of the evident insufficiency of the present available funds to complete the system, the city is contemplating the construction and equipment of a pumping station which will be below the desired standard and will serve a system at present less than half as complete as is necessary.

Vicissitudes of the Project

Briefly, the history of the project is this: The construction of a $1,000,000 high-pressure fire-service system was authorized in August, 1911, after the deficiencies of the existing fire service had been strongly urged by the Fire Prevention Committee of the National Board of Fire Underwriters. Plans and specifications for the construction of the distribution system and of the pumping-station equipment were submitted to the committee for approval in 1912.

The proposed system was to consist of 2.5 mi. of supply mains from the pumping station to a gridiron system of 14.3 mi. of mains 12 to 20 in. in diameter, protecting 550 acres in the congested district. The pumping station was to have a capacity of 18,000 gal. per min. at 300 lb. pressure.

In 1913 contracts were let for most of the materials, and deliveries were made. At the same time a hitch occurred over the location of the pumping station. Seven or eight proposed locations were suggested and rejected for various reasons during 1914, involving a large amount of ultimately useless surveying and planning as well as some trenching that had to be filled in again without accomplishing anything. Pipe laying was commenced in August, 1914, and 4 mi. of pipe was laid. Of this the report states:

The workmanship on this part of the contract was inferior, and great trouble was experienced in making the contractor comply with the specifications. A report of the engineer in charge, made to the Commissioner of Public Works through the division engineer on Jan. 20, 1915, called attention to much of this inferior workmanship, particularly in the manner of making and calking the joints. Competent men were not employed by the contractor in this work, and many of the tools required were not found on the job, much less used. Because of these conditions, the system did not meet the leakage-test requirements, and the engineer in charge refused to accept the lines laid and recommended uncovering and recalking the sections showing high leakage. Much of this has been done, as brought out later in this report.

. . . .

On Nov. 20, 1916, Clarence Goldsmith, an engineer lent by the Board of Fire Underwriters to take charge of the installation, who had refused, except in one instance, to approve any of the monthly estimates for payments on the pipe-laying contract because of the failure to meet contract requirements, was summarily dismissed from his position.

Joints Filled with Special Alloy—Work Poorly Done

Because of the crowded condition of underground structures, making it impossible in many instances to obtain the necessary clearance, it was decided to abandon the usual practice in such work of tying in bends and hydrant branches with lugs and steel tie-rods, and to depend upon a stronger joint by using an alloy of lead (developed after a series of tests). This alloy consisted of lead, tin and antimony, and under test gave a stronger joint than a plain lead joint and tie-rods, for the sizes of pipe used.

The original specifications called for a leakage not to exceed ½ gal. per lin.ft. of joint per 24 hr., but, due to poor calking, this allowance was not attained, and the requirement was raised to 4 gal., or about double that allowed on any similar system. Even with this new requirement, many sections laid in the first contract failed

to meet the specifications. During the spring and summer of 1916 many of these joints were uncovered and recalked, and at the present time most of the sections have a leakage under 100 lb. pressure of less than 1 gal. per lin.ft. of pipe joint per 24 hr. The maximum is 5.39 gal. and the average about 2.8 gal. For the total 6 mi. laid this corresponds to a total of 16,900 gal. per 24 hr. or 33 gal. per min.

Much Remains To Be Done

The report states that it is very evident that the City of Boston is in need of the service available from a modern, well-equipped and well-designed and powerful high-pressure fire-service system and that such a system has not yet been provided, although ample time has been consumed in its construction. This has been responsible in part for a wasteful expenditure of the funds available; and to finish the system to the degree necessary for the protection desired, additional funds must be provided.

It is recommended that a site for the pumping station be decided upon at once and a plant provided which will have an ultimate capacity of 24,100 gal. per min.; that the plant be designed so as not to depend on a single suction or discharge line and that it be connected to the system by three independent 20-in. mains; that the duplex system, as originally contemplated, be completed; that the system be tested under 300 lb. pressure for 24-hr. periods, at least monthly, to study leakage and develop weak joints, and that in the future more care be taken to follow the specifications.

The new system, or the part of it which is completed, is at present connected to two older high-pressure services by 16-in. mains, which give a pressure of only about 90 lb. at the hydrants.

News of the Engineering World

Progress of Ontario Hydro-Electric Commission Power Plans

The scheme for the development of additional electric power by the Ontario Hydro-Electric Commission at Chippawa Creek in the Niagara district, as noted in *Engineering News*, Nov. 30, 1916, was formally approved on Jan. 1 by the voters in 10 cities and 36 towns and villages of western Ontario. The following question was submitted:

> Are you in favor of having the municipality develop or acquire through the Hydro-Electric Power Commission of Ontario whatever works may be required for the supply of electric energy or power, in addition to such electric power as is already obtained under the existing contract with the Hydro-Electric Power Commission of Ontario?

The only adverse vote was that of the town of Goderich. This referendum was taken because of the criticism that the government had no mandate from the people for the expenditure of the large sum involved. Legislation will be introduced at the approaching session of the provincial legislature authorizing municipalities to contract for the development with the Hydro-Electric Commission, and to assume their shares of expense.

On Jan. 1, referendums were taken in interested municipalities on the "hydro-radial" railway from Port Credit to St. Catharines, a project to cost $11,360,000. It was widely approved, but was defeated in Hamilton, which would have been liable for bonds to the amount of $5,869,000. The project will not be abandoned.

Associated Societies of Baltimore

The several engineering and technical societies of Baltimore have been combined in one organization, known as the Associated Technical Societies of Baltimore. The committee which framed the prospectus of the association was composed of W. W. Pagon, representing the Engineers' Club of Baltimore, and the Baltimore section of the American Society of Civil Engineers, John B. Whitehead, American Institute of Electrical Engineers, E. E. Reid, American Chemical Society, Professor Christie, American Society of Mechanical Engineers, Clyde Friz, American Institute of Architects, Percy Nicholson, American Society of Marine Draughtsmen, and G. J. Requardt, representing the alumni societies jointly. The associated membership numbers between 500 and 600. The tentative draft of the articles of association define the society organization as follows:

> The governing body shall be a board of governors which shall consist of the presidents of the member organizations.
>
> The officers shall consist of a chairman, vice-chairman and an executive secretary-treasurer to be elected by the board of governors.
>
> Power shall rest in the board of governors to determine what constitute matters of policy, but the board of governors shall exercise decisive power as to all matters of purely routine organization questions. A majority of the board of governors shall constitute a quorum.
>
> The chairman and vice-chairman shall be elected from the board of governors and shall hold office for the term of one year, or until their successors on the board are elected by the respective organizations. The secretary-treasurer shall belong to one of the member organizations, but need not be a member of the board of governors. His term of office shall be for a period of one year or until his successor is elected.
>
> Dues shall be paid by the member organizations in proportion to their respective memberships and where individuals are connected with more than one member organization the per capita dues shall be paid equally by such organizations.

School for Army Engineers Reserve Corps Started in New York

A school for officers (and applicants) of the United States Army Engineers Reserve Corps was started in New York City on Jan. 3, by the joint military-engineering committee of the national engineering societies. This school has been organized on the authorization of Gen. W. M. Black, Chief of Engineers, U. S. Army, and with the approval of Gen. Leonard Wood, commanding the Department of the East. The school will be in charge of Capt. T. M. Robins, and he will be assisted by Captains E. D. Ardery, R. G. Alexander and L. C. Herkness, Corps of Engineers, and by

non-commissioned officers detailed from the Washington Engineer Barracks and West Point Engineer Detachment.

The school will meet for drill once a week (generally Wednesday nights) during the winter; outdoor work will be taken up in the spring. The weekly sessions will be given up to infantry and engineer drill, officers' schools, lectures and assigned problems. Methods used at the Military Academy will be followed; the early work will be intended to show how the reserve officers would have to proceed in organizing new engineer companies.

The New Orleans Bridge or Tunnel project has progressed a step by the state vote of Nov. 7, which authorizes an amendment of the Louisiana constitution permitting the City of New Orleans to construct a bridge over or a tunnel under the Mississippi River at that city. The vote was 26,189 for and 6,223 against.

A Manhole Explosion in the Edison conduits in South Boston, Mass., on Jan. 1 killed one person and injured a number of others. Examination revealed two leaks in a 4-in. gas main at the corner of L and East Third St. The pipes, said to be 20 years old, were uncovered by the Boston Consolidated Gas Co. and temporarily patched. The Edison Electric Illuminating Co. states that none of its circuits was broken by the explosion.

Agitation for a Street Tunnel on Second St., Los Angeles, Calif., is being pushed by an association of property owners. The tunnel was located and designed by the city a year or two ago, but no decision has been reached concerning its construction. It is planned to connect Hill St. with Clay St.; the tunnel width is to be 50 ft., so as to accommodate street-car tracks as well as ample vehicle driveways. The Second St. Tunnel Association, 331 West Second St., is now backing the project.

A Third New Railway Station at Buffalo is presaged in the approval by the Terminal Commission of plans for a new passenger and freight terminal for the New York Central Lines. The Lehigh Valley R.R. is already in its new station and that for the Lackawanna is fast approaching completion. All three of these stations are within an area of four blocks and the New York Central being immediately alongside of the Lehigh Valley. This new station will be on the site of the old, that is, extending along Exchange St. from Washington to Michigan St., and will have full passenger and freight accommodations. Public hearings are to be held on the design in the early part of the year.

Reconstruction of Lyman Dam, Arizona—The failure of Lyman dam, near St. Johns, Ariz., was discussed in "Engineering News," Apr. 22, 1915, p. 794, a brief description of the dam and reservoir being given at the same time. The reconstruction and safeguarding of this dam have recently been intrusted to the Field, Fellows & Hinderlider Engineering Co., Denver, Colo., the work to be done under the personal supervision of M. C. Hinderlider, of that company. The reservoir, the second largest in the State of Arizona, being next in size to the Roosevelt reservoir, is owned by the Lyman Land Co. The estimated cost of reconstruction is $100,000. The work contemplated includes, in the main, trenching to bedrock, the placing of about 220,000 cu.yd. of earth by hydraulicking it into place and laying a heavy surfacing of riprap.

Engineering Work on the "Eagles' Nest" Irrigation Project of the Cimarron Valley Land Co., Cimarron, N. M., has been placed in the hands of Bartlett & Ranney, Inc., Consulting Engineers, Dallas and San Antonio, Tex. This project is located in Colfax County, New Mexico, and includes the construction of a large storage dam and reservoir with a diversion dam on the Cimarron River, 30 mi. below the reservoir, and usual canal and irrigation structures for irrigating 30,000 acres of land. Construction of the "Eagles' Nest" storage dam, which is to be an arched masonry structure 140 ft. high on a radius of 155 ft., has been started. The dam is located in a granite gorge of the river at an elevation of over 8000 ft. above sea level. Neal Hanson is Supervising Engineer and A. P. Rollins is Assistant Engineer.

Substantial Progress on the Flood-Prevention Project on the rivers of Kansas and the adjoining states is being made, according to a report from the Engineering Committee of the Kansas Flood and Water Congress. The Federal River and Harbor Bill of July, 1916, provided for an examination by the War Department of the flood periods of the Kansas River and its tributaries, the Cottonwood and the Neosho Rivers, and for the development of a plan for flood prevention and protection. The Chief of Engineers assigned this duty to Colonel McD. Townsend, Corps of Engineers, U. S. A., who visited the state and held several conferences with the Engineering Committee and other members of the congress. He then directed Percival Churchill, United States Assistant Engineer, to represent him and to make a personal investigation of the territory under consideration. Mr. Churchill has been in Kansas since the last of November, has traveled over most of the more important streams, examined obstructions, bank erosions, existing works, many proposed reservoir sites and has collected miscellaneous data relating to various phases of the problem. It is understood that he will soon make a preliminary report to Colonel Townsend, outlining a future course of action. It is also expected that he will follow this by a thorough examination, based on this preliminary report.

PERSONALS

Crosby J. McGiffert, formerly Assistant Town Engineer of Montclair, N. J., has been appointed Acting Town Engineer, succeeding Edgar S. Closson.

A. A. Cook, formerly with the engineering corps of the Central R.R. of New Jersey, has been appointed Recorder of Deeds of Mauch Chunk, Penn.

George Mercer, General Foreman of Bridges and Buildings of the Duluth, South Shore & Atlantic Ry., has been appointed Superintendent of Bridges and Buildings.

C. R. Harding, formerly Chief Draftsman of the Southern Pacific Co., New York City, has been promoted to be Assistant Consulting Engineer, with office at New York.

Joseph R. Greenwood has resigned as General Manager of the Ballwood Co., and is now associated with Charles H. Higgins, Architect and Engineer, 30 Church St., New York City.

R. S. Clear, Assistant Engineer of the Duluth, South Shore & Atlantic Ry., Duluth, Minn., has been promoted to be Office Engineer, succeeding J. E. Bebb, resigned, as noted elsewhere.

Frank Helm, Office Engineer of the Atchison, Topeka & Santa Fe Ry., Western lines, Northern district, at La Junta, Colo., has been promoted to be Division Engineer at Slaton, Tex.

E. S. Shuler has been appointed City Manager of Sumter, S. C., succeeding L. E. White, resigned. Sumter was one of the earliest cities to adopt the city-manager form of government.

S. J. Maas, Office Engineer of the Missouri, Kansas & Texas Ry. at St. Louis, Mo., has resigned to become Resident Engineer of the Galveston, Houston & Henderson R.R., with office at Galveston, Tex.

A. Pearson Hoover, Assoc. M. Am. Soc. C. E., formerly Contracting Engineer for the John W. Ferguson Co., Paterson, N. J., is now associated with E. P. Goodrich, Consulting Engineer, New York City.

Ross McClave, of McClave & McClave, Consulting Engineers, New York City, has been appointed County Engineer of Bergen County, New Jersey, succeeding Henry Welles Durham, as noted elsewhere.

W. Watters Pagon, M. Am. Soc. C. E., recently associated with J. E. Greiner & Co., Consulting Engineers, Baltimore, Md., has opened an office at 1218 Fidelity Building, Baltimore, for general practice of structural engineering.

George W. Knopf announces that he has opened offices at 302 Pennsylvania Building, Philadelphia, Penn., for the practice of consulting engineering, specializing in the design and construction of complete industrial plants.

Dr. Herman M. Biggs, State Health Commissioner of New York, is to go to France soon, under the auspices of the Rockefeller Foundation, to conduct a campaign against the spread of tuberculosis among noncombatants.

F. W. Bailey, recently Resident Engineer of the Galveston, Houston & Henderson R.R., Galveston, Tex., has been appointed Engineer of Maintenance-of-Way of the San Antonio & Aransas Pass Ry., with headquarters at Yoakum, Tex.

F. R. Hesser, formerly Assistant Engineer of the Kansas State Board of Health, Lawrence, Kan., and recently with the General Fireproofing Co., Youngstown, Ohio, is now Senior Engineer of the Fireproof Products Co., New York City.

Henry Goldmark, M. Am. Soc. C. E., Consulting Engineer, New York City, has been appointed a member of the Board of Consulting Engineers for the New York State Barge Canal, to fill the vacancy caused by the death of Dr. Elmer E. Corthell.

R. B. Clapp, formerly with the Pennsylvania Water and Power Co., Baltimore, Md., has been appointed District Manager of the Andrews Bradshaw Co., steam-plant equipment manufacturers, of Pittsburgh, Penn., with offices at Cleveland, Ohio.

Max R. Hall, of the firm of Hall Brothers, Consulting Engineers, Atlanta, Ga., has been appointed Assistant Chief of

Construction for the City of Atlanta. The firm of Hall Brothers now consists of B. M. Hall, M. Am. Soc. C. E., and B. M. Hall, Jr.

R. E. McCarty, General Superintendent of the Pennsylvania Lines West of Pittsburgh, with headquarters at Columbus, Ohio, has bee elected Resident Vice-President at Detroit, Mich. He began his railway career in 1879 as a telegraph operator.

H. Malcolm Pirnie, Assoc. M. Am. Soc. C. E., has been admitted to the firm of Hazen, Whipple & Fuller, Consulting Civil Engineers, New York City. He is a graduate in sanitary engineering of Harvard University and has been with the firm since 1912.

R. W. Newton, Assistant Deputy Engineer of the Minnesota State Highway Commission, has been appointed Road Engineer of St. Louis County, Minn., at a salary o. $4500 a year. His headquarters are at Duluth. The county will spend $800,000 on road work in 1917.

R. S. Whiting, of Grand Rapids, Mich., formerly an architect of Boston, Mass., has joined the staff of the Trade Extension Department of the National Lumber Manufacturers Association, Chicago, Ill., and will have charge of work along technical and engineering lines.

F. T. Hatch, M. Am. Soc. C. E., Chief Engineer of the Vandalia R.R., St. Louis, Mo., by a change in scheme of organization of the company, has been appointed Chief Engineer of Maintenance-of-Way of the St. Louis system of the Pennsylvania Lines West of Pittsburgh.

R. C. White, Assoc. M. Am. Soc. C. E., Engineer of Maintenance-of-Way of the Missouri Pacific Ry., at Little Rock, Ark, has been promoted to be Superintendent of the Memphis division, with office at Wynne, Ark. Prior to April, 1914, he was Roadmaster of this division.

J. H. Nead, formerly Metallurgist and Engineer of Tests at the Watertown Arsenal, Watertown, Mass., has been appointed Metallurgical Engineer of the Minneapolis Steel and Machinery Co., Minneapolis, Minn. He is a mechanical engineering graduate of the University of Michigan, class of 1909.

Chester Harding, M. Am. Soc. C. E., Lieutenant-Colonel, Corps of Engineers, U. S. A., has been appointed Governor of the Panama Canal, to succeed Maj.-Gen. George W. Goethals, who recently resigned. Lieutenant-Colonel Harding has been Acting Governor for some time. He has been connected with the Panama Canal work since 1906.

A. L. Baldwin, Assistant Chief of the Division of Geodesy, United States Coast and Geodetic Survey, Washington, D. C., has resigned to become General Agent of the Northwestern Mutual Life Insurance Co. for the Washington district. Mr. Baldwin entered the Survey as an aid and after several years of field work he joined the office force as a computer. Mr. Baldwin was recently elected President of the Washington Society of Engineers.

A. R. Young, Assoc. M. Am. Soc. C. E., City Engineer of Topeka, Kan., for the past six years, has resigned, effective Feb. 1, to become Manager of the service department of the Western offices of the John Baker, Jr., Asphalt Distributing Co., of Chicago, Ill. Mr. Young was graduated from the University of Kansas in 1905, and was formerly in the engineering department of the Atchison, Topeka & Santa Fe Ry. at Chanute, Kan. From 1908 to 1910 he was City Engineer of Chanute, going from there to Topeka.

Wilbur J. Watson & Co. announce the formation of the Watson Co., Engineers, Cleveland, Ohio. The personnel of the new company includes: **Wilbur J. Watson**, M. Am. Soc. C. E., President and Chief Engineer; **W. P. Brown**, M. Am. Soc. C. E., Vice-President and Principal Assistant Engineer; **F. L. Gorman**, Designing Engineer; **R. S. Ferguson**, Construction Engineer; **N. H. Hick**, Building Engineer; **H. R. Hadlow**, Mechanical Engineer; **A. M. Felgate**, **W. J. Wefel** and **E. W. Bowen**, Assistant Engineers, and **H. H. Smith**, Inspecting Engineer.

T. B. Hamilton, recently General Manager of the Vandalia R.R., at St. Louis, Mo., has been chosen Resident Vice-President of St. Louis system of the Pennsylvania Lines West of Pittsburgh. The Vandalia R.R., long a subsidiary of the Pennsylvania R.R., is now operated as a part of the Pennsylvania Co., instead of independently. Mr. Hamilton is a graduate of Princeton University, class of 1888, and began his railway experience the same year as a rodman on the Jeffersonville, Madison & Indianapolis Ry. at Louisville. He remained in the engineering departments of the various subsidiaries of the Pennsylvania lines until 1903, during which time he served as Engineer of Maintenance-of-Way on three divisions. He then became Division Superintendent of the Erie & Ashtabula division, and later General Superintendent of the Central system of the Pennsylvania Lines West of Pittsburgh.

William M. Acheson has resigned as Division Engineer, New York State Highway Department, Division 6, to become Chief Engineer of the Crescent Portland Cement Co., Wampum, Penn. He was educated at Rensselaer Polytechnic Institute and Union University. He entered the employ of the Troy Water-Works Department in 1900 as a chainman. Two years later he was placed in charge of construction of the Quackenkill diverting dam. In 1904 he joined the engineering staff of the Panama Canal as a leveler. Subsequently he was promoted to be Acting Resident Engineer in the Bureau of Municipal Engineering and Engineer in charge of the Third district of the Pacific division, which included the Bureaus of Municipal, Sanitary Engineering and Building Construction. He left the Canal Zone in 1910 to become Supervising Engineer of the County Construction Co. in New York State. In October, 1913, he was appointed Division Engineer, New York State Highway Department.

Albert W. Newton, M. Am. Soc. C. E., Assistant to the President of the Chicago, Burlington & Quincy R.R., has been appointed Chief Engineer to succeed the late T. E. Calvert. He was born in Illinois. He was in general engineering practice from 1892 to 1900 in the Central West. His first railway experience was with the Chicago & Alton Ry. as Assistant Engineer in 1900. He joined the engineering staff of the Chicago, Burlington & Quincy R.R. in 1903 as Construction Engineer at St. Louis, Mo., in charge of the Monroe, Mo., to Mexico extension. In 1907 he was appointed General Inspector of Permanent Way and Structures in the office of the Vice-President at Chicago, Ill. For a few months in 1908 and 1909 he was Acting Division Superintendent at Creston, Iowa. In 1914 he was appointed Chairman of the Federal valuation committee of the C., B. & Q., and also Chairman of the engineering committee of the Western Group Presidents' Conference Committee on Federal Valuation. He retains both these offices.

Henry Welles Durham, M. Am. Soc. C. E., has been forced out of the office of County Engineer of Bergen County, New Jersey, by local politics. Mr. Durham was formerly Chief Engineer of the Bureau of Highways of the Borough of Manhattan, New York City. He was appointed County Engineer of Bergen County, New Jersey, in December, 1915. He had the misfortune to be a member of the Seventh Regiment, New York National Guard, and spent several months away from his office during the past year. The recent election changed the complexion of the County Board of Freeholders and great stress was laid upon the fact that Mr. Durham had not been a resident of the county before his appointment. One member of the board paid the following tribute to Mr. Durham's services: "Bergen County will suffer a serious loss if the Board of Freeholders dispenses with the services of Henry Welles Durham, the County Engineer, who has made good. The history of the engineer's office since he took charge a year ago has been one of efficiency, economy and splendid work." Another member of the Board said: "A man who has done as County Engineer what Mr. Durham has done must of necessity have made bitter enemies, and these enemies are the best proofs of duty well performed. The enmities he has aroused by his unrelenting opposition to crooked methods in the county road department make me all the more anxious to stand by him. I cannot bring myself to think that a majority of the Board of Freeholders elected to protect the taxpayers against looting and grafting will vote next Monday against the County Engineer who has done so much to help carry out the policies to which the Board was pledged. I hope those policies will not now give way to peanut politics." Mr. Durham will devote his whole time to private practice, with offices at 366 Fifth Ave., New York City.

OBITUARY

Edward L. Peene, Superintendent of the Water Bureau of Yonkers, N. Y., died Dec. 31, from pneumonia.

Sanford Horton, who had a part in the construction of some of the railways in Mexico, died Jan. 4, at his home in Continentalville, N. Y., aged 58 years.

Fred Walters, City Engineer of Manhattan, Kan., since 1912, was killed in an automobile accident near Manhattan on Dec. 9. He was a civil engineering graduate of the Kansas State Agricultural College.

Andy Brann, for 15 years senior member of the firm of Brann & Stuart, Engineers and Contractors, Philadelphia, Penn., died Jan. 5, at his home in that city. He was born in Ohio in 1849. He was connected with the construction of the famous Eads bridge over the Mississippi at St. Louis, Long bridge over the Potomac at Washington, D. C., the trainshed

of the Broad St. station, Philadelphia, and other notable structures.

James Skene, a railroad contractor, died Dec. 23 from pneumonia, at Seneca, S. C., where he was doing some work for the Southern Ry. He was born in Scotland and came to this country as a young man. He was well known in the West as a bridge contractor, having erected bridges over the Missouri and Rio Grande Rivers. He also had a part in the construction of the Queen & Crescent bridge over the Kentucky River. He was 71 years old and survived by three sons and two daughters.

ENGINEERING SOCIETIES

SOCIETY OF AUTOMOTIVE ENGINEERS.
Jan. 11. Annual meeting in New York City. Secy., C. F. Clarkson, 129 West 39th St., New York.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION.
Jan. 15. Fourth annual meeting in New York City. Secy., O. S. King, 120 Broadway, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at Society House, New York City. Secy., Charles Warren Hunt, New York.

INDIANA ENGINEERING SOCIETY.
Jan. 18-19. Annual meeting in La Fayette, Ind. Secy., Charles Brossmann, 1616 Merchants' Bank Bldg., Indianapolis.

WESTERN BRICK MANUFACTURERS' ASSOCIATION.
Jan. 20. Meeting in Kansas City, Mo. Secy., G. W. Thurston, 416 Dwight Building, Kansas City.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 23-25. Annual meeting in Montreal, Can. Secy., C. H. McLeod, 176 Mansfield St., Montreal.

ILLINOIS SOCIETY OF ENGINEERS.
Jan. 25-26. At Chicago. Secy., E. E. R. Tratman, Wheaton, Ill.

NORTH DAKOTA SOCIETY OF ENGINEERS.
Jan. 30-31. Annual meeting in Bismarck. Secy., E. F. Chandler, University, N. D.

OHIO ENGINEERING SOCIETY.
Jan. 31-Feb. 2. Annual meeting. Ohio State University, Columbus, Ohio. Secy., John Laylin, Norwalk, Ohio.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

NATIONAL LIME MANUFACTURERS' ASSOCIATION.
Feb. 6-7. Annual meeting in New York City. Secy., F. K. Irvine, 537 South Dearborn St., Chicago.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 7-9. Midwinter convention in New York City. Secy., F. J. Hutchinson, 33 West 39th St., New York City.

MINNESOTA SURVEYORS' AND ENGINEERS' SOCIETY.
Feb. 7-9. Annual meeting in Minneapolis.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 14-15. Annual meeting in Indianapolis. Secy., W. F. King, Indianapolis, Ind.

WISCONSIN ENGINEERING SOCIETY.
Feb. 15-16. At Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 19-22. Meeting in New York City. Secy., Bradley, Stoughton, 29 W. 39th St., New York City.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting in Ames. Secy., J. H. Dunlap, Iowa City.

The Franklin Institute will hold its annual meeting on Jan. 17 in Philadelphia.

The Louisiana Engineering Society will hold its annual meeting on Jan. 13 in New Orleans. The secretary is W. T. Hogg.

The Engineers' Club of Toronto will hold its annual meeting on Feb. 1. The secretary is R. B. Woolsey, 90 King St., West, Toronto, Ont.

The Montana Institute of Municipal Engineers will hold its annual meeting in Helena, Jan. 15 to 17. The secretary is J. N. Edy, Billings, Mont.

The Kansas Engineering Society wil hold its annual meeting Jan. 16 and 17 in Topeka, Kan. The secretary is C. A. Forter, City Hall, Topeka.

The New England Water-Works Association will hold its annual meeting in Boston on Jan. 10. The secretary is Willard Kent, Narragansett Pier, R. I.

The Franklin Institute will hold its annual meeting on Jan. 17, the paper of the evening being the "Panama Slides," by Harry Fielding Reid, Baltimore.

The Albany Society of Civil Engineers will hold its annual meeting on Jan. 23, in Albany, at Keeler's Hotel. The secretary is E. G. Raynor, Barge Canal Office.

The Engineers Society of Western Pennsylvania will hold its annual meeting on Jan. 16 in Pittsburgh. The secretary is Elmer J. Hiles, Oliver Building, Pittsburgh.

The American Institute of Consulting Engineers will hold its annual meeting on Jan. 15 at the Engineers' Club, New York City. The secretary is F. A. Molitor.

The Society of Constructors of Federal Buildings will hold its seventh annual meeting in Washington, D. C., Jan. 15 to 18. The secretary is Charles Reed Marsh, Brattleboro, Vt.

The American Society of Swedish Engineers will hold its annual meeting on Jan. 20 in the society's building at 271 Hicks St., Brooklyn, N. Y. The secretary is Erik Oberg.

The American Society of Engineering Contractors will hold its annual meeting Jan. 19 in New York City. The secretary is J. R. Wemlinger, South Ferry Building, New York City.

The Compressed Gas Manufacturers Association will hold its annual meeting Jan. 15 at 120 Broadway, New York City. The secretary is Otto S. King, 120 Broadway, New York City.

The Municipal Engineers of the City of New York will hold its annual meeting on Jan. 24 at the Engineering Societies' Building, New York City. The secretary is George A. Taber.

The Canadian Mining Institute will hold its annual meeting in Montreal on Mar. 7 to 9 at the Ritz-Carlton Hotel. The secretary is H. Mortimer Lamb, Ritz-Carlton Hotel, Montreal.

The Western Paving Brick Manufacturers Association will hold its annual meeting on Jan. 19 and 20 in Kansas City, Mo. The secretary is G. W. Thurston, Dwight Building, Kansas City.

The Illinois Association of County Superintendents of Highways will hold its annual meeting Jan. 18 and 19 at Urbana, Ill., in Engineering Hall of the University. The secretary is Walter E. Emery, Peoria, Ill.

The National Association of Master Gravel and Slag Roofers of America will hold its annual meeting, Dec. 16 and 17, in Washington, D. C. The secretary is H. B. Nichols, Whitehall Building, New York City.

The Central Railway Club holds its annual meeting on Jan. 12 in Buffalo. Election of the following officers will be announced: President, D. R. MacBain; vice-presidents, W. H. Sitterly, David D. Robertson, Frank C. Pickard. The secretary is Harry B. Vought, 95 Liberty St., New York City.

American Concrete Institute—The nominating committee has named the following candidates to be voted on at the annual meeting, Feb. 9: President, Prof. W. K. Hatt, Purdue University; vice-president, Sanford E. Thompson, Boston, Mass.; treasurer, Robert W. Lesley, Philadelphia, Penn.

The Oklahoma Society of Engineers recently held its annual meeting, at which Alfred Boyd, Dean of the School of Engineering of the Agricultural and Mechanical College of Stillwater, was elected president. M. L. Cunningham, State Engineer, first vice-president; F. B. King, second vice-president; J. P. Cloutz, third vice-president; H. V. Hinckley, Oklahoma City, secretary.

The Engineers' Society of Western Pennsylvania.—C. R. Yarnall, vice-president of the Nelson Valve Co. and of the Engineers' Club of Philadelphia, recently addressed the Engineers' Society of Western Pennsylvania on "Engineering Coöperation and Fellowship." He explained the methods and spirit by which the Engineers' Club of Philadelphia was able to put through its campaign for increasing its membership a year ago. Since the campaign the membership has increased—by 200.

The American Institute of Mining Engineers—The list of nominees submitted by the Committee on Nominations stands as printed in this column on Dec. 7, with the exception that C. W. Goodale, Butte, Mont., has been nominated for vice-president in place of Walter H. Eldridge, New York, who declined, and that Philip N. Moore, of St. Louis, has been nominated by petition for president. Sidney J. Jennings had already been named by the Nominating Committee as a candidate for president.

The National Lime Manufacturers Association will hold its 31st annual convention in New York City, Feb. 6 and 7, at the McAlpin Hotel. An unusual attraction will be the second American Complete Building Show, which will be held in Grand Central Palace. As in former years the American Ceramic Society, the National Paving Brick Manufacturers Association, the National Clay Machinery Association and the

National Building Brick Bureau will meet at the same time, in New York City. The secretary is Fred K. Irvine, 537 South Dearborn St., Chicago.

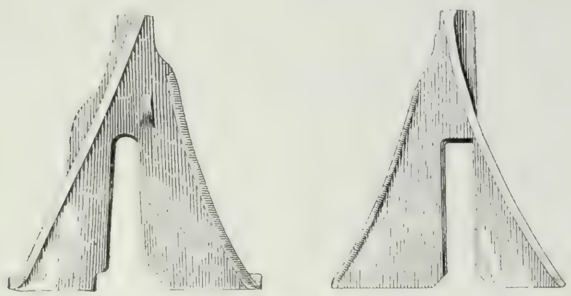
The American Society of Civil Engineers will hold its annual meeting on Wednesday, Jan. 17, in the auditorium of the Engineering Societies' Building, 29 West 39th St., New York City. This is the first annual meeting of the society to be held elsewhere than in its own building. In the evening a reception with dancing will be held in the Society House, 220 West 57th St. On Thursday there will be an excursion on the Hudson and East Rivers, starting at 10 a.m. from the ferry slip at the foot of Whitehall St. Thursday evening, John Howard Whitehouse, M.P., will speak at the Society House on "The Economic Conditions in England Due to the War." Following his address there will be a smoker.

American Institute of Weights and Measures—An association has been formed in New York City to oppose the compulsory use of the metric system. The constitution defines the objects of the association as the "maintenance and improvement of our present English system of weights and measures for the good of our commerce and industry and the well-being of our country," and "the promotion of wise legislation for the conservation of our basic English unit of weights and measures and opposition to hasty and ill-considered legislation involving changes from our fundamental English standard." In a circular letter just issued the Institute declares its belief that an organized effort is being made to force the adoption of the metric system in the United States by compulsory legislation. It urges that before any such legislation is undertaken it should be ascertained whether in the countries using the metric system the old standards do not still continue in use with resultant confusion. The Council of the Institute includes such prominent men as E. M. Herr, President of the Westinghouse Electric Co.; Henry M. Leland, President of the Cadillac Motor Car Co.; William Lodge, President of the Lodge & Shipley Machine Tool Co.; Henry B. Sharpe, Treasurer of the Brown & Sharpe Manufacturing Co.; Stevenson Taylor, President of the American Bureau of Shipping; Henry R. Towne, head of the Yale & Towne Manufacturing Co.; Worcester R. Warner, Vice-President of the Warner & Frazee Co., and D. H. Kelly, Secretary of the Toledo Scale Co. Those interested in the objects of the association are invited to apply for membership to any member of the Council.

Appliances and Materials

Wrecking Frog or Car Replacer

The Johnson car replacers, shown herewith, straddle the rail, with the narrow end resting on the rail head and the wider end on the rail base and ties. They retain their position without the use of spikes or clamps. The central flat portion (slotted for the rail) forms an incline, up which the derailed wheels ride, while the ribs guide them into position on the rails. They are openhearth steel castings weighing from 30 lb. each (for light logging or industrial lines) to 165 lb. for heavy locomotives, or 275 lb. each for 200-ton wrecking outfits. These replacers are handled by Clapp, Norstrom & Riley, of Chicago.



JOHNSON CAR REPLACER

* * *

New Type of High-Speed High-Vacuum Pump

A new kind of pump for exhausting vacuum tubes, etc., has been developed by Irving Langmuir of the Research Laboratory of the General Electric Co., Schenectady. The most notable performance characteristics are (1) extreme speed (3,000 to 4,000 c.c. per sec.), (2) simplicity and reliability, and (3) absence of a lower limit above zero to which the pressure may be reduced.

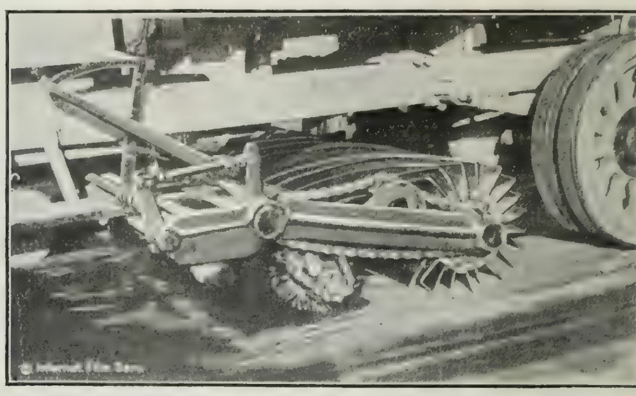
The operating scheme is novel: A blast of mercury vapor carries the gas by friction into a condenser chamber, the gas and vapor always being inclosed by cooled walls so that there can be no re-evaporation of vapor condensing thereon. (Where such re-evaporation takes place there is a backward diffusion which prevents the outward passage of the gas to be exhausted.) Because of this action and its vital importance the new exhausters have been termed "condensation pumps."

* * *

Motor Squeegee Street Washer

A demonstration was recently given in New York City of a motor-driven street-cleaning apparatus that combines a sprinkler, a broom and a squeegee. This machine is known as the "Sterling-Kindling Motor Squeegee Street Washer" and is made by the Sterling Motor Truck Co., of Milwaukee. It consists primarily of a special Sterling worm-gear-driven motor truck, carrying a 1000-gal. tank (see accompanying view). Ahead of the front fenders is a sprinkler pipe. Under the body of the truck are a second sprinkler pipe and a rotary sweeper broom, which may be let down in contact with the pavement, to loosen the dirt. Behind this and revolving in an opposite direction is a squeegee 19 in. in diameter and 8 ft. long, with helical rubber blades.

The squeegee roller and broom are flexibly mounted and counterbalanced in such a way that, when adjusted to a certain pressure against the street surface, the pressure remains uniform over inequalities of surface. A toggle-joint linkage terminating in a lever in the driver's cab makes it possible to throw the broom and squeegee driving attachment in and out of engagement quickly or to lift them out of contact with the pavement. They are driven from a secondary shaft of the truck transmission, which operates a worm gear that turns a wheel and shaft carrying the sprockets and chains. The tank is fitted with a water meter. This serves both to indicate the amount of water used (and thus the operator's industry) and in connection with a cyclometer, to give data for computing water consumption per square yard of pavement cleaned. The tank is equipped with separate valves near the front end for distributing water to the front and central sprinklers. The machine may be converted into a flusher by substitution of nozzles for the sprinklers.



STERLING-KINDLING MOTOR SQUEEGEE STREET SWEEPER AND WASHER

The cleaning capacity of the machine per day is claimed to be from 80,000 to 115,000 sq.yd., which is about 25 mi. of ordinary streets. This is the equivalent of from three to six horse-drawn street-cleaning equipments. A test by the Municipal Research Bureau of Milwaukee gave an average of 80,000 sq.yd. of pavement cleaned per day, at an average cost of 16.5c. per 1000 sq.yd.

Engineering News

VOLUME 77 JANUARY 18, 1917 NUMBER 3

Travis Tank and Sprinkling Sewage Filters, Paqueta Island, Rio de Janeiro

By Charles J. Seiber*

The Bay of Guanabara, on which the City of Rio de Janeiro is situated, is a body of water some 50 km. long and varying in width from 5 to 16 km. The entrance is quite narrow, and no river of any size discharges into it; but it receives the sewage from a population of well over 1,000,000. This body of water is one of the most beautiful in the world, and the authorities are very careful to adopt measures that will prevent the contamination of the bay.

Many of the islands that dot the bay are quite large and contain small villages. The Island of Paqueta, near the head of the bay, about an hour's sail by steamboat from the city, contains a community of approximately 5,000 people, and some 400 houses are connected to the separate system of sewers that has been laid through the island.

All the laterals feed into a main intercepting sewer, which contains four automatic pumping stations operated by electric motors, the office of these pumping stations being to raise the sewage from low to high level, whenever the elevation of the main interceptor falls to a point where its further continuance would carry it to too great a depth below grade.

The last of these stations pumps the sewage to a small settling tank. The outflow from this tank is controlled by automatic valves that feed the raw sewage to a circular Travis tank, constructed after the plans of the Hydrolytic Tank Co., of England. The effluent from this tank goes to sprinkling filters. Fig. 1 is a general view of the tank and filters, and Fig. 2 shows the details of the tank.

There are practically no trade wastes, the sewage coming almost entirely from residences with wide variations in the rate of flow. At the time of the writer's visit to the plant in January, 1916, the water-supply of the island was not up to normal, and the sewage could be classed as "strong." It was noticed that the raw sewage contained much solid matter and was almost black in color and fresh. The Travis tank showed very little scum and hardly any gas, and a marked progressive clarification was noted at each succeeding weir and an entire absence of odors. At the final outfall from the tank the effluent was quite clear, having somewhat of an amber color, but there still remained flaky solids, to a slight degree, the largest of these flakes being not over a half a centimeter in diameter and only a fraction of a millimeter in thickness.

FIG. 1. GENERAL VIEW OF SEWAGE-WORKS OF ISLAND OF PAQUETA, RIO DE JANEIRO, BRAZIL

After leaving the Travis tank the effluent passes into a channel at one side of a high-level sprinkling filter. A siphon, at one end of a traveling distributor, carries the effluent to the distributor pipes. The distributor (Figs. 1 and 3) is moved on three rails and covers the entire filter bed, which is 10 m. wide by 45 m. long. The distributor feeds only one-half of the bed, when running in either direction, the change-over being accomplished by a length of pipe partly filled with heavy oil.

When the carriage arrives at one end of the bed, it engages with stops that release one cable grip and engage another taking the rope traveling in the opposite direction. This is accomplished by means of the oil-filled

*Resident Engineer, Trussed Concrete Steel Co., Candelaria 2, Rio de Janeiro, Brazil.

counterbalance shown in Fig. 3, which after being brought to a level position by the stops is carried positively to its extreme position by the shifting of the oil in the pipe. This motion also operates gate valves on the carriage, which cuts off the effluent from one half of the distributor and admits it to the other half. By this means each half of the bed is closed at each passage of the distributor and is rested during the return passage. The distributor is operated by an endless wire rope driven by a 5-hp. electric motor, both the upper and lower filter beds being operated by the same motor. After passing the first, or high-level, filter very little solid matter remains, and the effluent appears to be colorless in the discharge weir.

From the high-level filter the effluent passes to the low-level one, which is an exact counterpart of the first. When

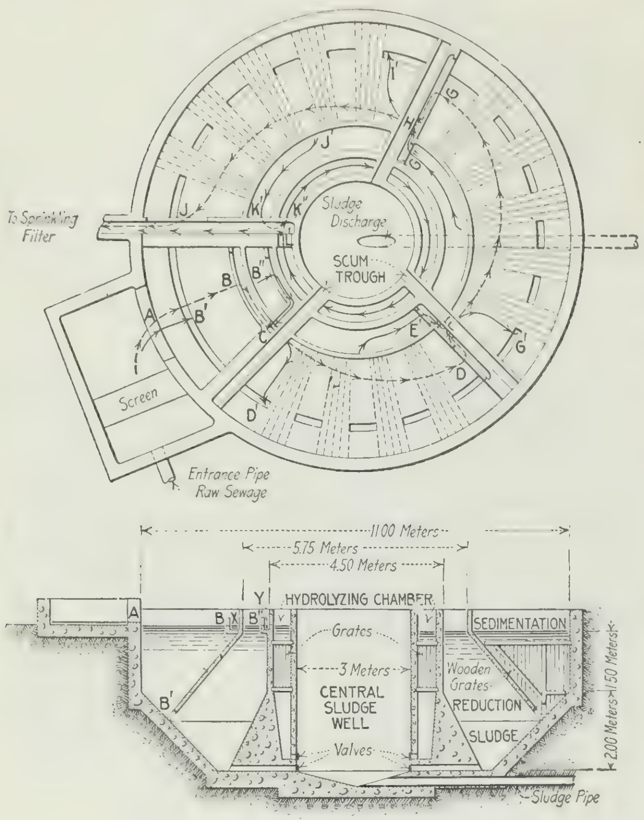


FIG. 2. PLAN AND SECTION OF TRAVIS TANK, PAQUETA SEWAGE-WORKS

A—Entrance weir to first sedimentation chamber. B—Weir to channel "x," from first reduction chamber. E'—Openings to first reduction chamber. C—Siphon to second sedimentation chamber. D'—Openings to second reduction chamber. D—Weir from second sedimentation chamber. E'—Weir from second reduction chamber. F—Siphon to third sedimentation chamber. G'—Openings to third reduction chamber. G"—Weir from third reduction chamber. G—Weir from third sedimentation chamber. H—Siphon to fourth sedimentation chamber. I'—Openings to fourth reduction chamber. J—Weir from fourth sedimentation chamber to outflow. K' K"—Siphon from fourth reduction chamber to hydrolyzing chamber. L'—Weir from hydrolyzing chamber to outfall. B"—Weir from first reduction chamber to channel "y"

the liquid discharges from the latter bed, there is not the slightest trace of solids or of odor, and in the channels no color can be seen. The writer held a glass of effluent against the white walls of the filter and could detect no trace of color, but on looking down through about 20 c.c. of liquid placed on a white paper a very faint yellow tinge could be detected. A bottled sample after one week was absolutely odorless.

The outfall to the sea may be seen in Fig. 1, just at the right of the gate in the wall surrounding the property. The beach here has a slight slope only, with hardly a meter of tide. An examination of the rocks in the vicinity showed no signs of deposit. The sea was quite clear, and the beach in front of the plant was being used by several bathers.

From all indications the plant appears to accomplish the desired results perfectly. No disinfection is used. The operator informed the writer that the sludge, of which there was a very small quantity, was removed two or three times a month and buried on the property. He had the day before our visit removed sludge and deposited it in a shallow excavation, at the left of the large tree appearing in Fig. 1. This sludge was uncovered and was absolutely odorless and inert.

The power house (at the left of Fig. 1) contains two Diesel engines direct-connected to 500-volt direct-current

FIG. 3. VIEW OF TRAVELING SEWAGE DISTRIBUTOR, PAQUETA SEWAGE-WORKS

generators, a very complete switchboard and recording devices and a storage-battery plant.

All machinery is of British manufacture. The complete system is cared for by six employees and is splendidly maintained, being a model of its kind.

The system was built and is operated by the Rio de Janeiro City Improvements Co., which controls and operates the complete drainage system of Rio de Janeiro. The writer is indebted to the company for its courtesy in allowing him to inspect and photograph the plant.

How Can the Engineer Improve His Public Standing?

By F. W. Hanna*

The engineer's standing (or lack of standing) in the public mind and in public affairs is due to (a) the nature of engineering work, (b) the public's method of valuing men and (c) the character of the engineer's education. The first of these causes is not susceptible of such changes as will materially affect the engineer's public status, but the second and third are not so strictly limited.

The remoteness of the benefit to be derived from a piece of engineering work makes its importance indistinct to the public vision. The design of a bridge is so far removed from its use in traffic that the public seldom connects the engineer with commerce and human travel; the survey of a reservoir site is not vividly enough related to the growing of crops on an irrigation project or the use of water from a faucet in the house to make vivid in the mind of the public the usefulness of the engineer.

*Consulting Engineer, United States Reclamation Service, Ankeny, Iowa.

Neither does the hazy concept of the part taken by the engineer in these enterprises permit the public to appreciate the amount of intelligence and labor devoted to the design and the survey.

These illustrations are typical of practically all engineering operations. The engineer is assumed to evolve railroads, power developments and irrigation projects as an ordinary, easy natural process. His unseen mathematical calculations pass with the public as rapid addition at best, and his fieldwork as mere ability to run a compass. The insight is little deeper than the public's knowledge or its tangible experience. This phase of the nature of engineering work is worthy of consideration, however, as the engineer must cope with it, and he should do it understandingly.

The public method of human valuation is generally imperfect, because its conclusions are usually drawn from a partial knowledge of the facts. Its facilities, time and ability for securing complete premises for conclusions are all limited. The public necessarily consists of a mixture of individuals with varying mental dimensions and varying education, all intensely employed in their own affairs. The public seldom searches deeply for facts, and it is impressed on the average only by obvious truth. This is why all reforms are so painfully slow in realization and is also why the services of the engineer to humanity are little understood and poorly appreciated. The engineer's only remedy for this trouble is to get the facts before the public so that they will be obvious to it, through use of the press, the school, the rostrum and literature.

The school, the press, the public rostrum and literature are the main sources of public information outside of the experiences in the daily routine of life. The public is ready to read entertaining newspaper accounts of engineering works, and the scenes of a play or the plot of a novel can well be centered about some great piece of engineering work. Few engineers can succeed in writing plays or novels; and were they to do so they would turn their talents in that direction, as did Robert Louis Stevenson and F. Hopkinson Smith. The engineer, however, may endeavor to interest writers intelligently in the human as well as the material side of his work, and he may also improve opportunities to lecture on engineering and related subjects, with resulting benefit.

Faced by such a literary and oratorical program the engineer will often shrink, rightfully from objection to self-advertisement, but wrongfully from fear of commercialization of his profession. Moreover, he generally feels incompetent to carry out his part in such a program, from lack of college training along certain lines. This indicates where some changes in our college engineering courses would be helpful.

The engineer on leaving college is not well balanced educationally. He is well equipped to grapple with the laws of nature, but not with those of human nature. He has been trained thoroughly, and rightly so, in all the natural, rational, pure and applied sciences, but generally he has had only a smattering of English, supplemented with a like smattering of German or French or Spanish. He knows but little psychology, political economy and sociology, but little law, too little of anything in fact that gives him an insight into human affairs outside of his own profession.

The college courses are only partly to blame for this state of affairs. The engineering student almost always sees his chosen profession too narrowly and avoids and slights the broadening subjects in his course of study. He conceives his profession to be that of converting the raw materials and potent forces of nature into human use, without seeing the necessary intervening and important conversion of his fellow beings into supporters of his projects. After some years of experience he learns that the latter is one of the big factors in his profession and then wishes that he could understand human nature and speak and write better.

The study of French or German or Spanish has a fine theoretical basis for its future utility in the engineering profession. A few of our engineers read engineering literature directly in these foreign languages, but most of us soon forget how to read them and depend on translations for their foreign information. A few of our engineers go into foreign lands and use directly the foreign languages learned in college, but the great mass of them find employment in their own country. Consequently, the large majority of engineers receive practically no other benefit from the study of foreign languages than that of general mental culture.

On the other hand, this large majority would receive the same mental culture and also an immense practical benefit through the substitution of a more thorough study of the English language and its literature. Let the engineer have enough rhetoric to make his tongue and pen certain of their ground, enough debating and oratorical work to induce a natural flow of speech while standing before an audience, and enough literature to loosen his poetical imagination and awaken his interest in the higher relations of mankind. He will then be better fitted to take his proper place in public affairs.

An intimate acquaintance in college with the fundamental laws of the human mind and with those of human society would be of profound service to the engineer in his dealings with the public. An understanding of these laws is just as essential to successful dealings with the public as is an understanding of the laws of inanimate nature and mathematics to the efficient handling of the material problems of engineering.

Due to his college training in mathematics, physics, mechanics, chemistry and the like, the young engineer readily and quickly manages problems involving their use. Occasionally an engineer has acquired an understanding of these fundamentals in his busy life of practice, but he was handicapped for their lack during several of the most useful years of his life. The engineer graduate now suffers a similar handicap in his knowledge of the human mind, human society, human institutions. He is compelled to buffet against the world for a long time before he is equipped to handle a position involving serious dealings with the public. While more liberal college training in psychology, sociology and political economy would not eliminate all of this buffeting, it would greatly lessen the length and severity of the apprenticeship.

The engineer's analytic habit of mind, his accuracy of thought and his honesty of purpose are excellent qualities for men in public service; but greater endeavor on the part of the engineer to secure public appreciation and better preparation of engineer graduates in their college work for public service will aid greatly in enlarging the engineer's share of appointments and elections to positions of public authority and influence.

Operating a Steel-Sharpening Shop

First-Prize Drill-Sharpening Article in the "Engineering News" Prize Contest

By J. E. O'Rourke*

Those engaged in rock excavation are beginning to realize more clearly every day the need of a well-equipped blacksmith shop for sharpening rock-drill bits. When hammer water drills were adopted at the Wisconsin Zinc Co.'s mines near Platteville, Wis., the management realized that hollow high-carbon drill steel required much greater care in handling than the solid steel formerly used with piston drills. Considerable thought was given this matter, resulting in the erection of a new blacksmith shop at the Champion mine. The site of this shop was carefully selected so as to be as nearly centrally located as possible, in order to furnish steel to four mines—namely, the Champion, Longhorn, Thompson and the Winskell.

Appreciating the fact that four mines were liable to keep the blacksmith very busy, the writer endeavored to arrange the shop equipment in such a manner as to avoid excessive handling of steel. With the idea of getting the greatest efficiency as regards the heating and the making of drill bits and shanks it was decided to install a Denver Fire Clay Co.'s oil forge and a Sullivan sharpener.

Attention is called first to the rack, Fig. 1, for dull steel from the Champion mine, the shaft of which is located about 50 ft. from the south end of the shop. When the dull steel is hoisted from the Champion shaft, it is carried to the shop, and each length is placed in the respective compartment allotted for it on the dull-steel rack, the longer lengths being placed in the lower compartments.

The movement of the steel through the shop from this point is as follows: From the dull-steel rack it goes to the upper deck of a double-decked stand in front of the oil forge, as shown in the plan, Fig. 3.

The fire opening in the oil forge is of sufficient length for placing nine steels in the fire at once. The writer experimented with different forging heats and, contrary to the recommendation of the steel manufacturer (which was 1,500° F.), it was determined that the most satisfactory forging heat was close to 1,650° F. A Wilson-Mauelen base-metal pyrometer was used. The fire end of this pyrometer was held in position in the fire by means of a home-made attachment (see Fig. 4) bolted to the forge cap.

Colonial steel was used, having the following analysis: Carbon, 0.88%; manganese, 0.35%; phosphorus, 0.011%; sulphur, 0.017%; scleroscope hardness, 0.44.

The blacksmith stands on the sharpener side of the double-deck stand shown in Fig. 3, with his helper on the opposite side. The smith takes a heated steel from the forge, and one step backward places him in position to operate the sharpener. The dressing of a bit requires about 30 sec.; however, the writer has often witnessed the completion of this operation in 20 sec. Much valuable time is saved by placing the finished bit on the lower deck of the double-decked stand, instead of following the old haphazard way of throwing it on the ground, where it will be in the way and must be picked up later.

The writer is very well aware of the efficacy of an intermediate or refining heat to remove forging strains, previous to tempering, but owing to the heavy steel demand and the fact that satisfactory results were obtained with two heats, it was decided to dispense with the refining heat. Two methods of tempering were practiced: One was to lower the temperature by partly quenching and then drawing the temper to the desired color; the other method consisted of plunging the bits in a brine of sal ammoniac, saltpeter and bromide of potash solution covered with about 6 in. of Houghton's No. 2 soluble quenching oil, the bit not being withdrawn until thoroughly cooled.

FIGS. 1 AND 2. DULL-STEEL RACK AND THE DOUBLE-DECK STAND

It is well known that brine as a tempering agent causes much faster contraction of the molecules than water, which contraction sometimes has a disastrous effect on the bit when drilling in lime rock; however, this rapid contraction was somewhat retarded by a protecting film of oil. The bromide of potash offset the injurious effects resulting from overheating. The other ingredients of the solution were added to soften and purify the water.

After the steels were cool, they were removed from the tempering tank and placed on the adjacent sharp-steel rack with shanks in the direction of the grinder near the shop door.

The final operation consists in grinding the ends of shanks perfectly true and square. This work is done by a No. 2 Willey direct-connected bench grinder (James Clark, Jr., Electric Co., Louisville, Ky.) equipped with 12-in. wheels. After grinding, the steels are replaced on the sharp-steel rack, whence they are carried to the collar of the Champion shaft.

*Engineer, American Zinc, Lead and Smelting Co., Granby, Mo.

Any mine operator who has ever tried to sharpen steels for two or more mines in one blacksmith shop will appreciate that it will be a matter of only a few days before one mine will have absorbed most of the steel, unless some steps are taken to prevent it. In order to provide against this, three double racks were erected along one side of the building. One of each of these sets of racks is open to receive the dull steel when it is brought from its respective mine. The other rack is protected by a wooden grating furnished with hinges and a lock. These locked compartments contain the sharp steel. A sufficient amount of steel is provided for each mine so that when a load of dull steel is delivered to the shop, it is counted and an equal amount of sharp steel is taken from the closed rack and returned to the mine, after which the dull steel is sharpened and placed in the closed rack under lock and key, awaiting the next day's demand. It can be readily seen that if the above system is religiously observed by the blacksmith it will be easily possible to keep the exact cost of steel sharpening for each mine, likewise the relative steel consumption.

The oil is stored in a pressure tank outside the building and is heated to the proper temperature by means of a coil placed in a stove, water being supplied to this coil from the mine-pump discharge column, and circulated through a hot-water jacket around the oil tank, thence

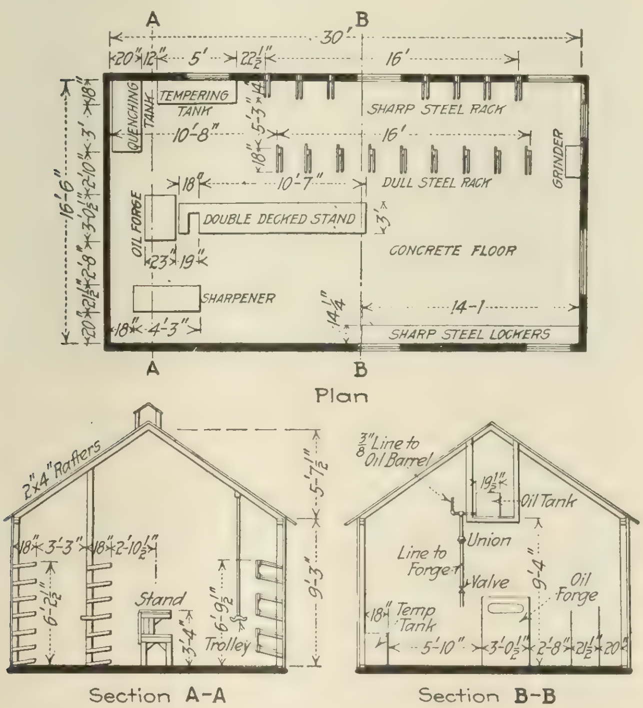


FIG. 3. DETAILS OF THE DRILL-SHARPENING SHOP AT WISCONSIN ZINC MINES

to the upper barrel, in which an oil reservoir tank is placed. In this manner a storage of about 50 gal. of warm oil is constantly provided.

Another kink consists of a trolley for supporting the drill-steel in the sharpener. A rail similar to a barn-door hanger is attached to the roof framing and carries two roller-bearing wheels in tandem, with a hanger between them from which is suspended a rod about 9 ft. long. The end of this rod is threaded to hold a double-swivel hanger (see Fig. 3), which can be adjusted instantly as to height. On this the drill-steel rests during the sharpening operation. Longer or shorter steels can be handled

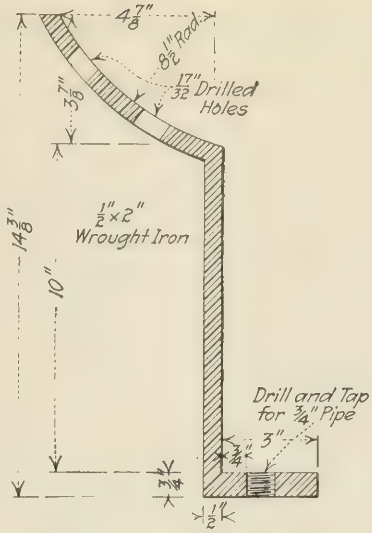


FIG. 4. ATTACHMENT OF PYROMETER TO FORGE

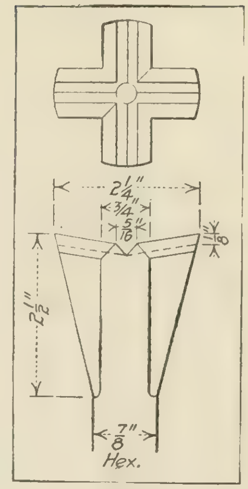


FIG. 5. DETAILS OF DOUBLE CROSSBIT

by running the trolley along its track. This eliminates the cumbersome tripod-steel support.

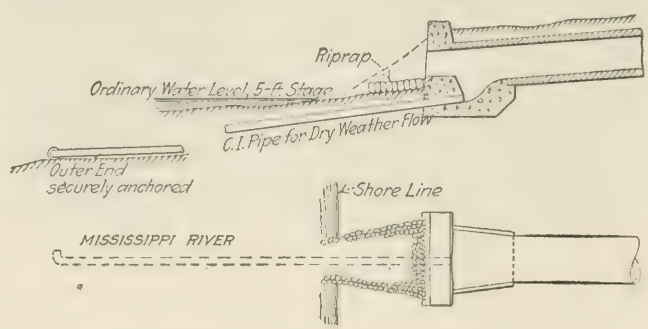
The type of drill bit used is shown in Fig. 5. It is the best bit for drilling Wisconsin limestone, when used in hammer drills, on account of its high penetrating qualities and ease of rotation.

An estimate of the total cost of this shop, with complete equipment including building, is approximately $2,300.

The writer is greatly indebted to Douglas C. Corner, former Superintendent of the Champion mine (now a member of the engineering staff of the American Zinc, Lead and Smelting Co., Granby, Mo.) for his kind assistance in preparing this article.

River Outlet for Combined Sewers

In connection with a recently published report on sewerage improvements at Davenport, Iowa, John W. Alvord, consulting engineer, Chicago, submitted a sketch for typical outlets to the Mississippi River, reproduced herewith. The general scheme is sewage disposal by dilution. Where the inverts of the mouths of the various outlet sewers would



PROPOSED RIVER OUTLET FOR SEWAGE DISPOSAL BY DILUTION AT DAVENPORT, IOWA

be above ordinary water level a run of cast-iron pipe would take the dry-weather sewage to a submerged outlet Where submerged dry-weather flow outlets are impracticable, vertical bar screens might be installed in the future; but these are to be avoided where and as long as possible on account of the trouble and expense of cleaning the screens. It is thought that complete disposal by dilution will be practicable at most of the outlets.

Cleveland's New Water-Intake Tunnel Under Lake Erie Completed

SYNOPSIS—A large part of the cost of soft-ground tunnels driven by the hydraulic shield method is due to the cast-iron lining usually employed. The new water-intake tunnel under Lake Erie at Cleveland, Ohio, is lined with cast concrete blocks at a great saving in expense. The tunnel is also notable for its rapid advance, for the disastrous gas explosion which occurred in it and for its erratic course.

A three-mile subaqueous tunnel driven by hydraulic shield and lined with concrete blocks has just been completed at Cleveland, Ohio. It is the new West Side water-intake tunnel under Lake Erie. Original methods of construction give it a place of first importance among recent soft-ground tunnels.

Notable speed of advance was recorded—a maximum of 886 ft. in one heading in a month. The soil is a stiff clay, free from risk of runs. However, marsh gas occluded in thin sand seams of the clay made the tunneling as hazardous as coal mining and, after a great gas explosion occurred in one heading, led to the adoption of regular coal-mine precautions, with the help of the United States Bureau of Mines.

By far the longest continuous compressed-air section ever employed was carried in the land heading—it attained a final length of 14,000 ft. Just as remarkable a novelty is the erratic course of the tunnel. Owing to difficulty in controlling the direction of the shield, and also to an inadequate survey force, the line departed by as much as 180 ft. from its intended course, and from the intended grade line by 6 ft. above and below.

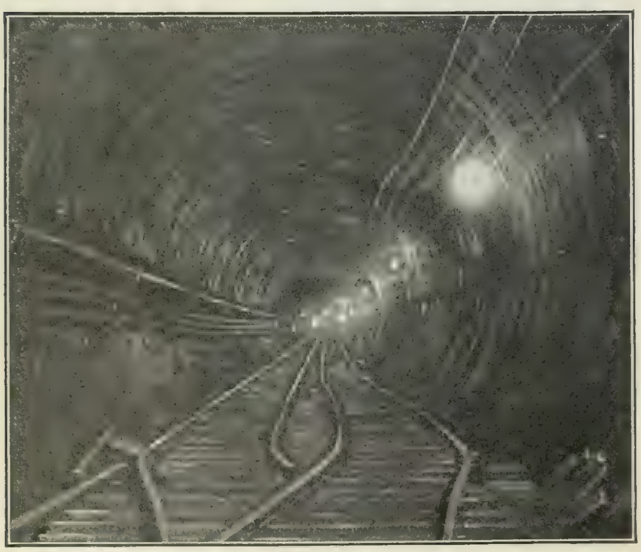


FIG. 1. INTERIOR OF CLEVELAND TUNNEL

An account of the construction in its early stages, with map of route, drawings of block erector and other details, was printed in *Engineering News* of Jan. 7, 1915, pp. 4-8.

The concrete blocks then described were used for only a small part of the tunnel, however. After the first 2,500 ft., a new type of block lining, designed by the engineers of the Cleveland Water Department, was adopted, and this "city block" was used exclusively thereafter.

The tunnel is 10 ft. in inside diameter, 16,088 ft. long, and lies at a depth of 100 to 110 ft. below lake level. The grade falls about 10 ft. from the starting point at the old Crib 4 to the new intake, Crib 5. The water depth ranges from 40 to 52 ft., leaving a roof 50 to 70 ft. thick between the tunnel and the lake bottom. The soil is nearly all clay, from lake bottom down to depths of at least 130 ft. It lies in distinct beds up to 15 ft. in thickness, and occasionally has sand seams or is apparently mixed with sand.

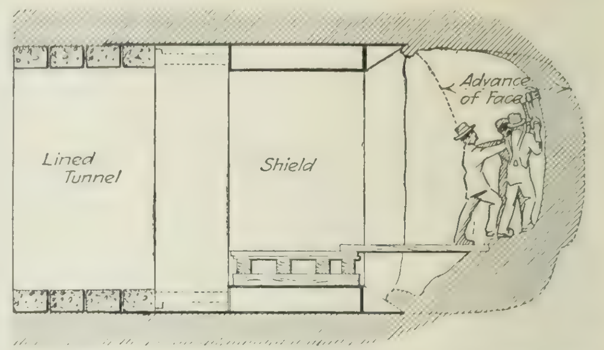


FIG. 2. PROCEDURE IN EXCAVATING AT TUNNEL FACE

In a few of the twenty or more exploration borings, traces of gas were encountered in thin strata lying at depths of 85 to 105 ft.

The broad conclusion from these borings was that at a depth of 100 ft. or so a good, stiff clay would be found throughout the proposed tunnel. This depth, which is practically the same as that of the two smaller tunnels (5 and 7 ft.) driven many years ago from the shore to Crib 4, a distance of 1½ mi., was adopted for the new tunnel, which was to extend 3 mi. out under the lake from Crib 4.

As stated in the article referred to, the clay in question is water-tight, and so stiff that free-air excavation in it is quite feasible; and although the tunnel was started with compressed air "as a precautionary measure," yet it was hoped that "as it progresses it will be possible to take the pressure off." In spite of this hope it was found impossible, and the work was done with compressed air throughout; 20-lb. pressure was carried on the average.

At Sta. 40, in the land heading, a trial was made of working in free air. It was continued for three weeks, and then compressed air was resumed. Superintendent Van Duzen said the compressed air tended to hold the ground in the heading excavation and provided easy drainage of the shield water by means of the blowpipe; in free-air working, a pump had to be set up to remove the incoming water.

While the clay is stiff, holding so well that the unbalanced inward pressure of nearly 30 lb. per sq.in. did not prevent leaving the face open and unprotected during the idle Sundays, yet it is cut through by innumerable jointing planes. There are two series of these joints, with strike about northeast-southwest and with dip about 60° westward and 30° eastward respectively. The clay face always tended to squeeze in, very slowly, by sliding on these joints.

The shield is a simple riveted-steel double-ring structure, without interior partitions or diaphragm. It has a cast-steel cutting edge of the usual type, but no hood. Its total length is 15 ft. 1 in., its diameter 12 ft. 2⅛ in.; these proportions made it rather hard to guide. It is driven forward by 12 jacks with 9-in. plungers—some of the identical jacks used in the shields of the Hudson River tunnels of the Pennsylvania R.R. at New York ten years ago. Jack pressures of 1,500 to 3,000 lb. per sq.in. were required during the progress of the work. The higher figure represents high shield resistance, but it is partly explained by the fact that the upper three jacks were usually out of service, owing to inability to set the closing block of the ring (no reverse-taper key block being provided).

The original plan of working was to do all the excavating with a rotary cutting machine built into the front of the shield. This machine and its use were illustrated in *Engineering News* of Nov. 5, 1914, and Jan. 7, 1915. The machine continued in use in the land heading for about half the length of the tunnel. It was removed in December, 1915, and the rest of the work was done by hand excavation.

The immediate reason given for abandoning the machine was a change in the nature of the ground. Subsequent experience showed, however, that hand excavation

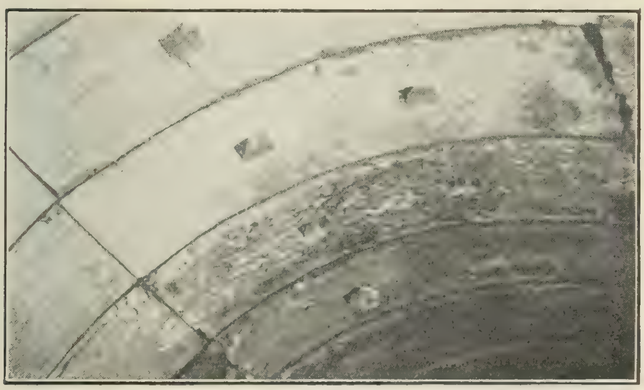


FIG. 3. CONCRETE BLOCKS IN PLACE IN TUNNEL

gave nearly as rapid progress with the same number of men, was free from liability to interruption, avoided the use of electric motors at the face and saved the operating cost of the machine.

Hand excavation was done with clay knives—semicircular drawknives fitted with 15-in. spade handles, as illustrated in *Engineering News,* Aug. 24, 1916. It was done in two lifts. The upper half of the face was first cut ahead, the men working on a scaffold of a few planks supported at the rear by a permanent platform built in the shield ring, and at the front by gains cut in the clay face. The entire distance of advance of the shift, up to three or four rings of blocks (4½ to 6 ft.), was excavated in the upper half. Then the planks were removed and the lower half was excavated. When the advance exceeded three rings (it reached eight rings per shift), one-half was excavated and the corresponding rings were set, and then the second half of the advance was cut out.

The regular heading gang consisted of 8 to 12 men, four working in the face (three cutting and one passing the pigs of clay back to the shield platform), and the others passing clay from the shield platform to muck cars and handling the cars.

In the block lining resides one of the main innovations adopted by the engineers of this tunnel. The blocks were used as a substitute for the brick lining of the earlier intake tunnels at Cleveland.[1] Ordinarily, cast-iron segmental lining is used when the shield method of advance

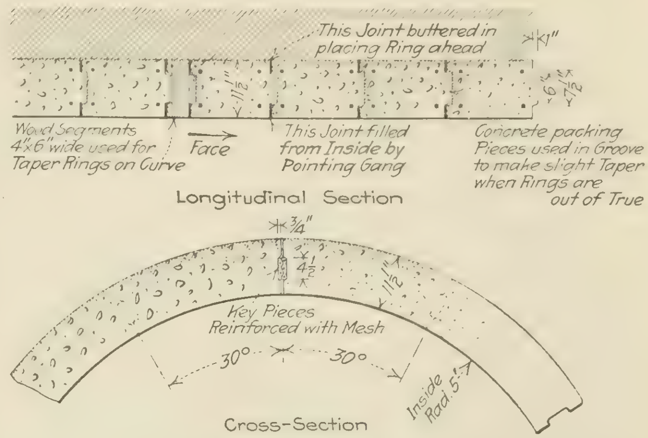


FIG. 4. SKETCH SHOWING CONCRETE BLOCK DESIGNED BY CITY'S ENGINEERS

is adopted, but the high cost of cast-iron lining made some other solution desirable in this case.

Various patented concrete blocks were considered, and the Parmley block was used for 2,500 ft. of the land heading. The city's design was then adopted, however, and was used for the rest of the work. It was laid with rings breaking joints (Fig. 4), whereas the Parmley block was laid with continuous longitudinal joints. The delay and inconvenience of placing reinforcement in the ring joints were factors in changing over to the city design of block.

The lining is 11½ in. thick and each ring is 18 in. long. Other dimensions are given in Fig. 4. There are six blocks to the ring, all alike. No taper rings were molded, but filler pieces were used to make the slight adjustments required on account of the blocks building longer on one side or on top.

As the blocks are equal, the sixth block of a ring can not be placed until the shield has advanced another shove. For this reason, generally, the upper jacks of the shield were not used, which resulted in less compression of the lining at the top and therefore a tendency of the

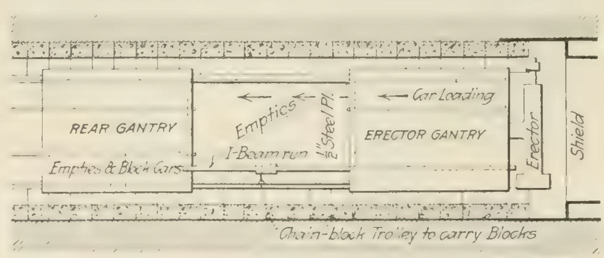


FIG. 5. SECTION SHOWING ARRANGEMENTS FOR HANDLING MATERIALS AT TUNNEL FACE

rings to lean forward successively more. In some parts of the work, it was therefore necessary to insert 2- to 4-in. fillers at the bottom about every 50 ft. In the crib heading, a temporary wooden key block was generally placed to get the use of all the jacks. This was replaced by a concrete block as soon as the next shove was made.

[1]These include a 5-ft. tunnel 6,600 ft. long completed in 1874; a 7-ft. tunnel of the same length built in 1888-'90; and a 9-ft. tunnel 5 mi. long completed in 1903.

A pointing gang worked 100 ft. or more back from the shield, filling all joints showing on the inside and producing a smooth, finished surface. The invert was pointed-up in some cases by a separate gang working well back of the first. This second gang cleaned the bottom (under the track) and pointed-up, leaving the tunnel in a practically finished condition.

The high jack pressure often required in shoving the shield produced a certain amount of splitting and spalling of the blocks. When spalling occurred, it was generally at the rear edge of the leading ring, where the raised

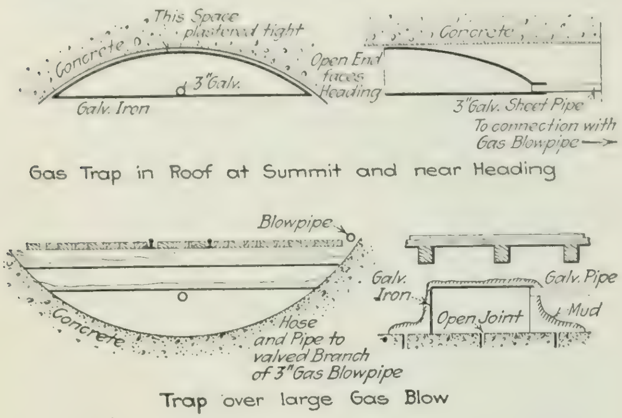


FIG. 6. ARRANGEMENTS FOR DRAWING GAS FROM TUNNEL

borders of the ring-joint mortise tended to spall away. Sometimes unequal bedding of the leading block against the two blocks back of it led to transverse cracking or breaking of the block against which the jack bore. Not many of these cases were considered serious enough to require cutting out the cracked block. In such cases, however, the work was done at some point back in the tunnel rather than stop the heading progress to replace the block at once.

Handling Blocks and Muck

Handling the blocks into place in the ring was done by a pneumatic erector, a jack pivoted at the front of a gantry frame dragged along by the shield. The erector was illustrated in *Engineering News*, Jan. 7, 1915.

About 14 ft. back of the erector gantry was a second gantry frame, for unloading the blocks from cars, as the

FIG. 7. VIEW OF LAKE CRIB

erector gantry was too low for running these cars through. An I-beam runway extended forward from the top of the rear gantry, under the erector gantry to its forward end; a chain-block trolley running on the I-beam lifted a block from the car (two blocks were loaded on a flat-car, one on top of the other) and skidded it forward to a position under the erector.

Muck cars were loaded under the erector gantry on the side opposite the block runway. A steel plate placed in the space between the two gantries, between the outer rails of the two tracks, allowed cars to be transferred from the right-hand empty track to the left-hand loading track and yet allowed loaded cars to be run straight back on the track for outgoing full cars.

The two gantries and the plate between, together with tracks, were hitched together and to the shield, so that they were dragged forward as the shield was shoved, and kept all parts in proper relation.

A single track was laid in the tunnel, with passing sidings at intervals. Haulage was done by compressed-air locomotives in the long air section of the land heading, and by a gasoline locomotive in the 7,000-ft. free-air approach through the old 7-ft. tunnel. Charging stations for the compressed-air locomotives were placed at ½-mi. intervals.

In the crib heading, a 300-ft. hauling rope pulled by electric hoist was used to overcome an upgrade against

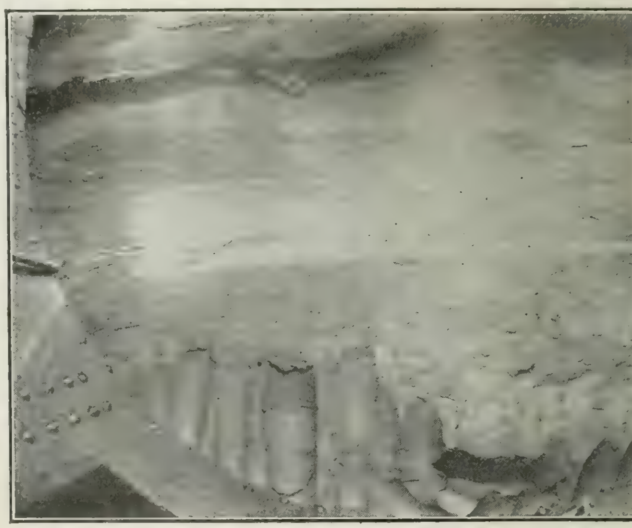


FIG. 8. SANDY SEAM IN CLAY, CRIB HEADING

loaded cars; but after the complete banishing of electric equipment from the compressed-air sections because of explosion danger, the cars were pushed by hand.

The work throughout was run in three shifts of 7 to 8 hr. each, but only the day shift carried pointing and cleaning gangs. The rate of pay for compressed-air work was $4.50 during the larger part of the work. There was no Sunday work.

Marsh-Gas Difficulties

The common occurrence of marsh gas in the Cleveland clay was known before the tunnel was started, and some of the exploration holes had encountered traces of gas. The explosion danger was therefore well known. From the beginning, open lights, matches and similar sources of ignition were barred, and these precautions were enforced more strictly as the work proceeded and an occasional inflow of gas was found.

The gas occurred in an erratic manner. Often the seepage was strong enough to make a blowing noise. If in the invert, it would bubble up through the slight amount of shield drainage that collected at the cutting edge in the bottom of the face.

The biggest inflow was struck in the crib heading by the afternoon shift on Saturday, July 22, 1916. The workmen on the night shift at the face were so much bothered by the quantity of gas (which reduced the oxygen by dilution, the marsh gas having no directly poisonous effect) that they had to stop work after a few hours. An 8-ft. summit in the tunnel about halfway out, 650 ft. from the airlock, made it difficult to get in or out, as the gas pocketed at the summit; yet the shift got out safely.

The Great Explosion

An air vent was placed in the low-pressure compressed-air line at the summit the next day (Sunday), during which, as usual, work was suspended. No shifts went in on Monday, but work was to be resumed at midnight Monday. The shift went in at 8 p.m., so as to get through

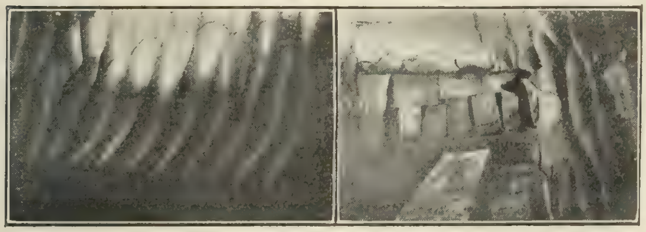


FIG. 9. SLIP SEAM IN CLAY FACE, AND USE OF KICKING STRUT TO TURN SHIELD (LAND HEADING)

earlier because of survey work which the acting foreman—S. H. Vokes, a civil engineer in charge of the survey work in both headings—had to do the next day.

About an hour later the air-pressure gage in the engine room was reported to be erratic, having jumped to 30 lb. suddenly and then gone back. The superintendent went down and found the lock closed, and the lock tender inside the tunnel trying to open the inner door. Some time later this man released the door and got out, with the report that something had happened.

Two rescue gangs that went in were overcome; nearly every man in each died. The leader of the second gang reached the summit, and lay there, kept alive by the air vent, for four or five hours before a party with smoke helmets brought him back.

A rescue party from the Pittsburgh Bureau of Mines station arrived half a day later and took charge of rescue and safety arrangements.

The something that had happened in the tunnel was a great gas explosion in the forward half, probably extending from the face some 800 ft. back to the summit. It blew out half a dozen large sections of roof, and through these holes the tunnel was filled solid with muck for 290 ft. It killed all the men where they stood. The hoist at the summit was blown 15 ft. back. Ties were bunched solid, 25 in a group, sheared out from the rail spikes. Ties far back near the airlock were broken downward. Near the summit, cable-hanger hooks were bent backward.

Most of the roof-arch blocks blown out by the explosion fell into the tunnel. A few blocks, however, were never recovered. They probably were forced out into the surrounding clay.

Closing the holes in the lining was done by digging away the clay enough to allow placing timbers outside, supported on the lining at either end of the break. The holes were bricked up, on inside centering, while clearing of muck advanced.

The coal-mine men sent by the United States Bureau of Mines, headed by W. J. German, stopped the replacement of electric-light wires which was in progress the day after the explosion, and thereafter banished all electric circuits and motors from the tunnel. The erector-traversing motor, which is thought to have furnished the spark for the explosion, was replaced by a chain-geared air motor. Storage-battery headlights were provided for general illumination at the working points, and storage-battery cap lights were furnished to the men. The only electric circuit allowed was a single telephone line from shafthouse to heading. At times of especially heavy gas flow even this was disconnected.

Coal-Mining Safety Precautions

Tests of the tunnel air were instituted. Samples from points near the gas "blowers" and from various other selected points were taken at the start. These showed alarmingly high percentages at some points; as much as 17% was found at the face, before resumption of driving. When no gas traps had yet been put in, a large part of the tunnel was at times filled with a gas mixture of explosive proportion (4 to 12%), producing conditions which were in the highest degree dangerous. Constant inspection by safety lamps was therefore instituted, firebosses being secured from the Pittsburgh coal-mine region, so that there was a man on duty every shift. Vacuum-tube samples of the tunnel air were taken weekly and sent to the Pittsburgh station of the Bureau of Mines for analysis. The gas was found to be pure methane (CH_4).

Gas traps were placed to catch the larger part of the gas before it could diffuse through the tunnel. These are sketched in Fig. 6. The main trap over the blower that was responsible for the explosion is an inverted pan of sheet iron placed under the track and piped to the

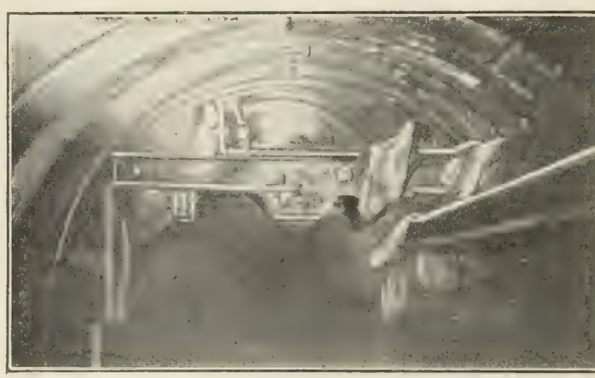


FIG. 10. VIEW IN CRIB HEADING, SHOWING ROOF

blow line by 3-in. hose. The lining joint nearest the blower was left open, while the other joints were calked and pointed-up tight. This arrangement succeeded in bringing practically all the flow to the trap.

Two roof traps were placed in the crib heading, and one in the land heading, at 200 to 400 ft. back of the face. These are sheet-iron funnels fitting the upper segment of the arch curve, facing toward the heading and piped at the smaller rear end to the blow line. As the air movement in the tunnel is backward toward the lock—the low-pressure supply line discharges near the face—the gas is carried toward the trap and is drawn off by the suction.

The importance of these precautions was made evident at every test. By shutting off the plug-cock in the tee

where the trap hose connected to the blowpipe, and thus stopping the suction at the trap, the floor trap sent gas enough into the tunnel to produce an explosive mixture several feet away (as shown by safety-lamp test) within a minute or two.

Estimates of the rate of gas inflow at the main blower of the crib heading indicated that, when not trapped, it filled half the length of the crib heading with an explosive mixture in the upper half of the tunnel in one hour.

Clearing the Shield by Water Jets

The north shield (crib heading) was found to have an abnormally high jacking resistance when work was resumed after the explosion. Soon it was noticed also that the new lining placed back of the shield tended to spread several inches, as soon as the tail of the shield moved off it. The shield evidently was dragging along a rough skin of caked material that resulted in leaving excessive voids behind the shield.

Indications of similar trouble having appeared in the driving, the conclusion was reached that some grout had adhered to the shell of the shield at the time of starting from the shaft, when a little grouting had been done. This skin of grout, apparently, caught some of the surrounding clay during the long stoppage of the shield after the explosion, and dragged this clay along.

To cure the trouble, the crib superintendent, J. R. Johnston, led three ¾-in. jet pipes forward to the cutting edge and, bending them around the edge, shoved them back 5 or 6 ft. Two of these were at the horizontal center line and one at the bottom. By forcing water at high pressure through the pipes just before the shove, it was hoped to lubricate the skin of the shield and prevent adhesion of clay. The scheme succeeded. The trouble with spreading of the lining disappeared.

Similar trouble, of lesser degree, in the land heading resulted in the jet-pipe system being adopted here also. It proved particularly useful in helping to swing the shield around a sharp curve which was necessary to bring the two headings to junction.

Serious Faults in Alignment; 180-Ft. Divergence

The tunnel was rather irregular in its course from the start, both in grade and in line. The land heading diverged laterally from true line in the first two or three thousand feet by amounts of several feet to one side and the other. In grade it was not quite so erratic at first, but before Sta. 40 was reached it dipped down 4 or 5 ft. below grade.

The initial troubles were caused by the heading foremen's inability to control the shoving of the shield. The irregularity of the forward face of the lining blocks—which afforded no such definite plane as the machined face of a cast-iron lining ring—was a factor in this.

Further, the blocks crowded back a little as the jack pressure was applied, and sometimes they spalled or cracked, as already mentioned. The fact that the shield is longer than its diameter, and the inability to use the upper jacks because of omission of the key block of the last ring, contributed toward making the shield hard to manage.

Worse divergences started before the end of the first mile. Beginning about Sta. 45, the tunnel took an irregular course, bearing off to the east of true alignment, diverging more or less in ratio of distance, until at Sta. 66 it was about 170 ft. off line. Thence to Sta. 86 its course was roughly parallel to the true line (at about 170 ft. distance). In the next half mile it made partial recovery, getting back to within about 100 ft. of its intended location. Its course then ranged between 110 and 135 ft. off the true line.

The grade of the tunnel is also irregular, but much less so than the alignment. The lowest and highest points are about 6 ft. below and above the intended grade, and in place of the intended very flat drainage gradient toward the outer end of the tunnel (to bring any entrained air to the pumping station) there is a reverse grade on some sections. The maximum slope is nearly 1% up, in the outward direction, and this prevails on a length of about 600 ft.

These great divergences of the tunnel are in part explained by the statement that for many months the men at the shield had no alignment marks set for them within 1,000 ft. of the face. There was only a single survey engineer for the tunnel, and he had to work most of the time with no assistance beyond that of a borrowed tunnel workman. The survey work was done under the hampering conditions of an unusually long compressed-air section, where the atmosphere often was badly fogged by the discharge of the compressed-air locomotives.

Proof that lack of alignment marks near the face had much to do with the divergence from line is found in a comparison of the conditions as to line and grade. A simple device for checking the downward or upward inclination of the shield was provided, in the form of a carpenter's level hung longitudinally in the shield. The heading foreman could read the level at all times, before and after the shove, and thus knew whether he was headed up or down. With respect to line, on the contrary, there was no guidance whatever. Through a large part of the construction no sighting points were set in the tunnel, and no sighting line was provided in the shield by which its direction of pointing could have been judged if there had been center-line marks within sighting distance.

The crib heading experienced divergences somewhat similar to those of the land heading, but much smaller. Laterally it remained fairly straight; its grade conditions were bad. A summit of about 8-ft. height occurs near Sta. 6 + 50, and in the next four or five hundred feet the tunnel goes down again nearly to true grade line.

When the two headings approached within about 1,500 ft. of junction, a new set of careful surveys was made by E. Statham, an experienced tunnel-survey engineer. With the data thus obtained, the positions of the two headings were computed and a reverse-curve course was laid out to bring them to junction. A grade of some 3½% was required on this course, the land heading descending and the crib head ascending to the junction.

That the shields could be managed with a high degree of precision was demonstrated when the headings swung around the curves (of about 180-ft. radius). The shield of the crib heading was brought around this curve excellently, with no other means than the jacks and jetting pipes. In the land heading, however, it was thought necessary to use a kicking strut, a 12x12-in. timber from the cutting edge at the inside of the curve to an abutment placed against the opposite side of the face excavation.

The headings were holed through on Dec. 14, 1916, and the shields brought together later.

The tunnel was designed and its construction begun under C. F. Schulz, Commissioner of Water, assisted by C. P. Jaeger, Deputy Commissioner. Mr. Schulz resigned early in 1916, when over half the length of the tunnel had been driven, and Mr. Jaeger was in full charge until he in turn resigned, in September. The tunnel was completed under the administration of G. B. Dusinberre, Commissioner, and J. T. Martin, Deputy Commissioner. Throughout the work, G. C. Van Duzen was Superintendent.

The tunnel was originally estimated to cost about $900,000, and because this was some 12% below the lowest bid obtained from a contractor, the city undertook the work by its own labor. The actual cost of construction is known to exceed the advance estimate considerably, but no figures are available.

Ruin and Recovery of Saratoga Mineral Springs

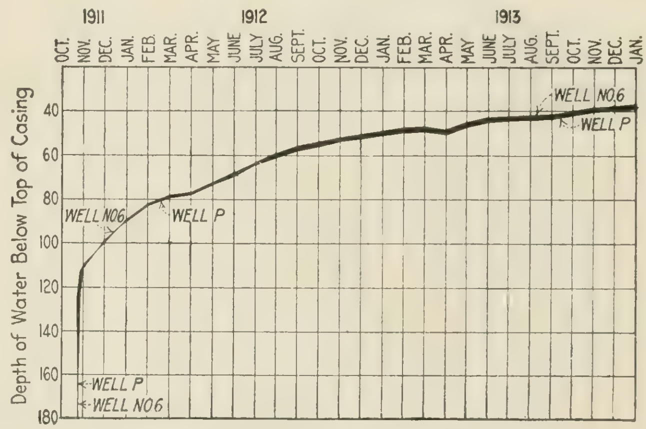
By Charles G. Anthony*

Far back in the early ages of geologic time a fault occurred in the complicated strata of rocks and other deposits overlying the original gneiss on the site of what now is Saratoga, N. Y. Along the line of this fault, which runs generally northeast and southwest with a trend to the west, the rocks on the westerly side of the crack were displaced from their counterparts on the easterly side for a distance of approximately 250 ft. Through this break in the layers of the earth's surface the waters of the springs of Saratoga first reached the surface. Along this fault and on its east side every known spring of the Saratoga system is now to be found. Many deep wells were drilled on the west side of the fault, but only soft pure water was found, while only a few feet across the fault on the east side the drill always releases highly carbonated mineral water. Many such mineral wells have been drilled, and at the present time all the springs and bores, about 150 in number, are found in a narrow belt about 2,000 ft. wide paralleling the fault for a distance of 4½ mi.

About 20 years ago a company located at Saratoga and started to separate the carbonic acid gas from the water, liquefy it and place it on the market in 20- and 50-lb. tubes. The gas business was highly profitable. Other gas companies located at Saratoga. The natural flow from the springs and wells could not satisfy the demand; deep-well pumps were installed, and for a period of 15 years they were operated day and night. One company pumped 290,000 gal. of water daily. There were five companies operating. Springs that, from the earliest times of their uncertain tradition, had been bubbling and effervescing ceased to flow. Springs that spouted jets of water 50 ft. into the air died out, and the orifices became dry holes crowned with cones of tufa. As the mineral-water level receded, the pump barrels were lowered deeper and deeper until at the end of 20 years the commercial bandits had ravished one of nature's most wonderful laboratories, so slowly constructed through the ages of layer upon layer of rock deposit.

The extent of the depletion was exactly determined five years ago after the State of New York by condemnation took possession of the 640 acres of property. In October, 1911, all pumping was stopped by the state. The gas plants were dismantled, and several men were employed to measure the water levels in the well. For the first few days after pumping stopped, the measurements were taken hourly; later on they were taken daily, and finally as the rise became less pronounced the readings were taken once a week. Curves showing the rise in water level were plotted for each of the 110 wells. All the curves are of the same character, so only two are reproduced here. These two wells, *P* and No. 6, are 1½ mi. apart and are separated by the deep valley of Coesa Creek.

The chart shows that at the time the pump barrels were drawn, in October, 1911, the water level was 182 ft. below



RISE IN WATER LEVEL OF TWO SARATOGA WELLS AFTER PUMPING WAS STOPPED

the top of the casing. Both of these wells when first drilled flowed naturally at the mouth of a 6-in. casing. There has been no change in the water level since January, 1914, showing that, 2.2 years after pumping stopped, the water reached its maximum elevation. The ratio of gas to water is not now as great as it was when pumping started 20 years ago, or these two wells would now be flowing. The mineral content of a few of the springs was so depleted that at the present rate of change these springs will not reach their normal mineral content for 25 to 30 years, and as a paradox some of the springs are now higher in mineral than when pumping started.

*Chief Engineer, State Reservation, Saratoga Springs, N. Y.

Obtaining Potash from Seaweed in the Sargasso Sea is a project which is to be undertaken by W. S. Warner of Tampa, Fla. Mr. Warner was formerly a sea captain, and has also done work in the development of the Florida phosphate deposits. He plans to build an 8,000-ton vessel of reinforced concrete, 300 ft. in length, 50 ft. beam, and 24 ft. depth of hold. The vessel is to be subdivided by bulkheads into water-tight compartments, and is to be equipped with machinery for hoisting the seaweed from the ocean and reducing it to ashes. As the seaweed is raised from the water, it will be run through three successive sets of heavy rolls which will remove 85% of the surplus water which it contains. After passing through rotary drying kilns, the seaweed will be burned and the ashes, in which the potash content is concentrated, will be discharged into the hold of the vessel. The equipment is planned to be capable of hoisting, drying and burning enough seaweed to produce 200 tons of ashes per day. Captain Warner claims that the Sargasso Sea is a region of such continuous calm, with freedom from both wind and wave, that the work can be carried on continuously without interruption, and there will be no difficulty in transferring the accumulated ashes from the seaweed-gathering barge to the steamers which will visit it regularly to transport the ashes to shore. The amount of seaweed in the Sargasso Sea is so vast as to be beyond estimation. Steamers, however, can navigate the sea and the patches of seaweed in it are not continuous.

Rock-Fill Dam Has Timber Face

By Kenneth A. Heron*

A low rock-filled dam in which the upstream face is well protected by a heavy planking has recently been constructed on the Goose Lake Valley Irrigation System in Oregon.

The principal source of water for the system is Drews Creek, which has a drainage area of 211 sq.mi. of mountain country west of the valley. The months of heaviest stream discharge are April and May, which in this locality are before the irrigation season. After the middle of the latter month in normal years the flow is very little. To conserve the entire stream discharge for irrigation and power purposes a large rock-fill dam has been constructed in a narrow cañon on the creek about 8 mi. above its outlet into Goose Lake. The dam consists of a rock fill 65 ft. high, with downstream slope of 1 on $1\frac{1}{2}$, a 10-ft. crown and a reservoir side sloping at 2 on 1. It will impound 62,000 acre-feet and backs water up Drews Creek 8 mi. The main portion of the fill consists of only the larger rock from the hillside quarries (Fig. 3). In finishing the fill, however, all the material from the borrow pits was used. The reservoir side of the fill is hand-placed dry wall 5 ft. thick at the crown and having its back slope 3 on 1. On top of this is a double-thickness plank facing tied to the bedrock in the creek bottom and sides with a masonry and concrete cutoff wall. This cutoff was placed in such a manner that, if at any time in the future it is desired to replace the timber face with a reinforced-concrete face, it can be done without any material alteration in the present construction except removing the timber face. At the time this work was done a concrete face was considered, but the use of concrete on any large scale was prohibited on account of the fact that the nearest railroad point was 65 mi. from the dam site. It is probably just as well that the timber face was placed instead of a concrete one, as it is serving its purpose very well and also because some settlement has taken place in the fill, which might have caused openings in a face of concrete, but has not harmed the more elastic timber face. On the upstream side of the cutoff wall in the creek bottom an earth-fill was placed to insure against any seepage at that point.

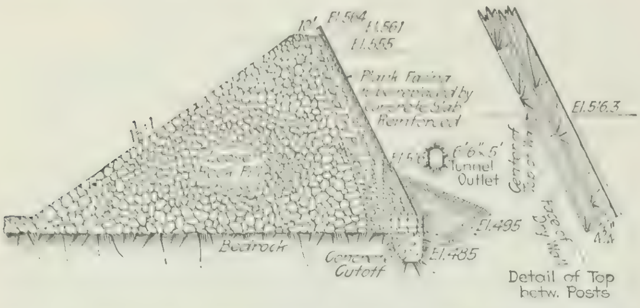


FIG. 1. SECTION THROUGH DREW'S DAM, GOOSE LAKE VALLEY IRRIGATION DISTRICT IN OREGON

A spillway 120 ft. wide, with its lip 9 ft. below the crest of the dam, was excavated through the solid rock on the north side of the dam.

The main reservoir outlet consists of an unlined tunnel through the cañon wall around the south end of the fill. Two 2x5-ft. Coffin gates set in a shaft near the upper end of the tunnel form the principal control works. A smaller outlet designed for power purposes, a 36-in. steel pipe, is embedded in concrete and masonry through the center of the dam. A 36-in. sluice gate on the upper end of the pipe controls the flow.

FIG. 2. UPSTREAM PLANK FACING TO DREW'S ROCK-FILL DAM

*Chief Engineer, Goose Lake Valley Irrigation Co., Lakeview, Ore.

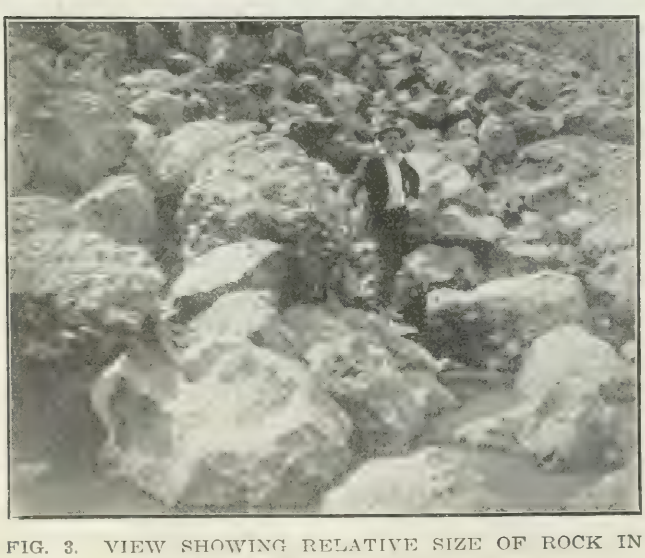


FIG. 3. VIEW SHOWING RELATIVE SIZE OF ROCK IN LOWER PART OF DREW'S DAM

Refitting an Oil-Burning Ship for Coal is not an immensely difficult operation if means are provided for carrying coal fuel. The change in the boilers consists merely of removing the burners and oil piping, air-controlling mechanism and special brickwork, and substituting a few necessaries such as grate bars and fire doors. Where steam-atomizing burners are used, the grate bars and bearers are usually retained while burning oil, and merely covered with a protecting layer of firebrick. George Simpson, naval architect, presents in the note section of the "Journal" of the American Society of Naval Engineers, for November, some rules for arranging the bunkers for alternate use with either fuel. Briefly, the cross bunker is to be arranged adjacent to the fire room and is to consist of two thwartship oiltight bulkheads of predetermined capacity. There is to be a centerline oiltight bulkhead dividing the cross bunker into port and starboard compartments, and in addition there should be partial swash bulkheads extending throughout the upper half of the bunker.

Nonfireproof Institutional Buildings in New York City Made Safe Against Fire

SYNOPSIS—Methods employed by City of New York in making safe many of the originally nonfireproof institutional buildings under the Department of Charities. Main reliance is on vertical firewalls, which in case of fire permit ready horizontal transfer of inmates to an adjacent safe section under same roof. Additional protection in the way of signals, pipe lines, chemical engines, fireproof doors and windows, etc.

With the award of the contract to the Werner-Huberty Co. on Nov. 2 for the remaining portion of the work comprising the improvements in the three groups of buildings on Blackwells Island, the Kings County

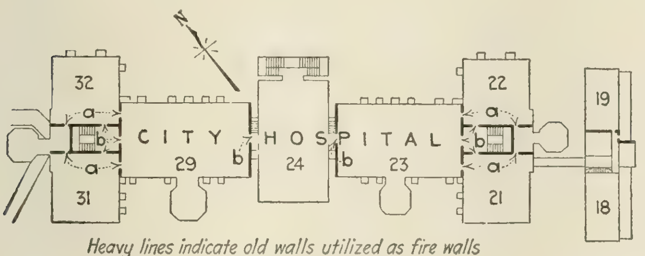


FIG. 1. PLAN OF CITY HOSPITAL BUILDING, SHOWING OLD WALLS UTILIZED AS FIREWALLS

Hospital group in Brooklyn and the isolated buildings scattered throughout the greater city, all the fire-protection work contemplated in the Department of Public Charities is now contracted for. Similar work in the buildings on Randalls Island and in the New York City Farm Colony on Staten Island was completed last year under contract with the Spuyten Duyvil Construction Co.

Inasmuch as safety to life problems are comparatively new and as these alterations are the most extensive of large occupancy and recommended the installation of additional water mains, pumps, standpipes, hose, fire extinguishers, etc., the construction of numerous outside fireproof balconies with stairways, outside fire escapes both of the usual patterns and of the helical-chute type. The total estimated cost of the work in the 32 buildings was $149,000, and this amount was appropriated for the purpose by the city.

Before advertising for bids, however, the city engaged H. F. J. Porter and A. L. A. Himmelwright to review the findings of the committee and make a further detailed study of all the buildings under the jurisdiction of the department, numbering 206. From their report most of the following data are gleaned.

General Protection Methods Followed

The character of the buildings ranged from the recently completed fireproof buildings with incombustible floor finish, trim, etc., to temporary frame structures; but the large majority were of the nonfireproof type three to five stories high, with masonry walls, wood interiors and wood roofs covered with tin, slate, or tar and felt roofing.

The varied occupancy of the buildings—from infants to adults of both sexes, including the feeble-minded, blind, aged, and helpless hospital patients—still further complicated the fire-hazard problems. It was impossible, therefore, to follow any set rule in the treatment of the buildings; each had to be considered separately, solving the problems presented in each and taking advantage of any favorable conditions that existed. In this manner the most practical and economical treatment that would provide reasonable safety to life and protection to property was determined for each building.

In nearly all the larger buildings masonry dividing walls were found, which originally were exterior walls before wings and additions were built. Such of these

FIG. 2. TYPICAL BUILDINGS TO WHICH FIREWALLS HAVE BEEN ADDED

Buildings at New York City Farm Colony, Staten Island. In building on left new firewall, shown projecting above roof, has been built. In building on right an existing wall has been made into a firewall

any such work that has thus far been undertaken, a brief history and description of them will be of interest.

Immediately after the Asch Building disaster in March, 1911, the late M. J. Drummond, then Commissioner of Charities, became solicitous for the safety of the helpless wards of the city filling the numerous nonfireproof institution buildings in his department. Upon his request a survey was promptly made by a committee that inspected 32 of the principal buildings having a walls as occupied strategic positions and could readily be developed into and be utilized as firewalls were recommended to be so converted. In this manner the danger zone from fire to both life and property in these buildings was reduced by vertical subdivision. This principle of the division of the fire hazard by utilizing existing walls or firewalls was found to be quite generally applicable and was recommended and later adopted on the grounds that it secured largely increased safety at less

cost than any other treatment that had been previously suggested.

The report also embraced a complete design for a fire-signal system for all the buildings in each group. This system was specially adapted to the character of the occupants and signaled only those who were in the danger zone and automatically called the fire-fighting forces to the fire and notified the central office.

The fire alarms that had been in use were a code of whistles blown from the boiler plant in each group. These were pronounced unsuitable and inadequate because of possible failure and always delay on account of the necessity of telephoning from the building in

FIG. 3. FIREDOORS AND HORIZONTAL EXIT, INFANTS' HOSPITAL BUILDING, RANDALLS ISLAND

which the fire occurred to the boiler plant, and the unnecessary alarm of those not in the danger zone, the excitement often injuring those who were very ill and weak and retarding their recovery.

For the groups of buildings on Randalls Island and the Farm Colony, Staten Island, which are isolated from the city fire department protection, chemical fire engines and special local fire-fighting brigades were recommended. The minor fire hazards now usually designated as housekeeping conditions were all pointed out, and the most practical manner of eliminating them was suggested in the case of each and every building.

This report was approved and adopted by the city, and Messrs. Porter and Himmelwright were engaged to prepare plans and specifications and to supervise the work of construction. The most urgent of these improvements were contracted for and completed last year, and the remainder are now in progress. A general idea of the character, location and number of the buildings embraced in this work will be given by the accompanying table. The total contract cost of the protection to 206 buildings was $117,000.

How Protection in City Hospital Is Accomplished

A very good idea of the manner in which all the buildings are being made safe can be obtained by a description of the treatment of a few that are typical.

The City Hospital, which is the main building of the City Hospital group, will be an excellent illustration of the treatment of the large hospital buildings. A small-scale floor plan is reproduced herewith (Fig. 1). The building is four stories and basement in height. It has stone walls, wood interior and a wood roof covered with slate. Its capacity is 1000 beds, and its

BUILDINGS PROTECTED AGAINST FIRE FOR THE DEPARTMENT OF PUBLIC CHARITIES, NEW YORK CITY

Group	Location	Character of Inmates*	Number of Buildings† Institutional	Service
City Hospital	Blackwells Island	General hospital and surgical	15	5
City Home	Blackwells Island	Aged, blind, neurological	23	9
Metropolitan Hospital	Blackwells Island	General hospital, surgical, tubercular	21	6
Kings County Hospital	Brooklyn	General hospital, surgical, tubuercular, aged, blind and cripples	28	7
Randalls Island	Randalls Island..	Feeble-minded children	31	7
Farm Colony	Staten Island	Poor, aged, but able-bodied	14	6
Sea View Sanitarium.	Staten Island....	Tubercular..........	13	2
Cumberland St	Brooklyn	General hospital, surgical, infants	2	1
Coney Island.......	Coney Island....	General hospital, surgical	4	2
Isolated buildings...	Greater New York	Administration buildings	8	2
			159	47

Grand total = 206

* The average population in all the groups is about 17,000. † Service buildings include boiler houses, laundries, workshops, storehouses, kitchens, bakeries, garages, stables, etc.

normal occupancy when filled with patients is from 1400 to 1500 persons, there being 400 to 500 nurses, attendants, surgeons, visitors, help, etc. A large number of the patients are bedridden and helpless. The standpipes are connected with the house water-supply system. One fire-engine company is located near the middle of the island and requires 5 min. to reach the building. Other fire-department apparatus and men from Manhattan cannot reach the building in less than 40 min. A fire in any part of the building would endanger the whole structure and annex and would jeopardize the

FIG. 4. HORIZONTAL EXIT THROUGH FIREWALL IN FARM COLONY BUILDING

lives of all the occupants. The fire-drill scheme proposed, in case of fire, to call all the help from the service buildings by means of a code whistle at the boiler house and attempt to extinguish the fire and empty the building of all the occupants. The possibilities of such a procedure on a stormy winter night were very discomforting to the Commissioner of Charities, but it was the best that could be done under the existing conditions.

The accompanying floor plan indicates that the building consisted of an original building 24, with two wings 23 and 29 added later, and after that two additions at each end 21, 22, and 31, 32, with an annex 18, 19 connected with the main building by a bridge at the second-floor level. The heavy dividing lines indicate existing masonry walls occupying strategic positions that are to be converted into firewalls, thus dividing the main building into seven vertical sections or fire units, as they are designated, and the annex into two additional units. Between units 21 and 22, and 31 and 32 are fireproof stair halls and stairways inclosed by 17-in. brick walls.

All the walls to be converted into firewalls are to be extended through the attics and roof and to an average height of 3½ ft. above the roof and are to be coped. The woodwork on opposite sides of these walls is thoroughly isolated. All openings in these walls, except specified doors to be used as horizontal exits and designated as *A* and *B* doors, are to be bricked in solidly the full thickness of the walls. Where there is any probability of fire spreading around the ends of these walls, one or two vertical lines of windows are fireproofed by substituting metal trim and sash and wire glass for the present windows. All wood cornices and projecting wood roofs within 5 ft. on each side of the line of the wall are to be replaced by hollow metalwork, fire-stopped along the line of the firewalls and duplicating in design and color the woodwork replaced.

All the present woodwork in the door openings in the firewalls is to be removed, including all trim, flooring, etc. The head and jambs are to be finished in hard plaster, and a concrete with a cement-finished sill is to be built up from the wall by corbeling out the wall 4 in. on each side of the opening, so this sill will extend under the firedoors in the closed position in all cases. Standard sliding Class A firedoors are specified to protect all openings in the cellars and attics, and hinged Class B standard firedoors, finished in harmony with the trim of the wards into which they open, protect the openings in the other stories.

This treatment converts the walls shown into real firewalls, making them practically as effective against the spread of a fire from one unit to another as if separated by a party wall. In other words, they divide the main building into seven separate and different buildings in so far as the fire hazard is concerned. Consequently, only about one-seventh of the occupants and one-seventh of the building can be endangered by fire at any time, no matter where it may occur. The fire hazard to both life and property in this building is therefore by this simple treatment reduced to only one-seventh of what it was formerly. Neither is it necessary by this plan to move the patients out of doors, as was formerly the case.

The horizontal-exit plan has the further advantage that the helpless and bedridden patients can be moved in their beds without discomfort or injury, that those physically able to walk or crawl may themselves reach safety without assistance or fear of injury to themselves by falling down stairways, and that when the horizontal exits are being used by the occupants the stairways, fire escapes, elevators, etc., are free and unobstructed, thus enabling the fire-fighting forces to reach the fire in the minimum time and fight it with the maximum efficiency.

In all cases at least two exits of sufficient capacity and as remote from each other as practicable are provided on each floor in each fire unit. Horizontal exits between wards through which beds are to be moved are 5 ft. 6 in. wide and 7 ft. high in the clear. Helpless patients are to be placed on beds near the horizontal exits, and these beds are fitted with special nonabrading, ball-bearing, nonswiveling casters with 3-in. diameter wheels for the head legs only. This arrangement preserves the stability of the beds the same as usual and permits the easy removal of the patient in his bed by a nurse or attendant lifting the foot of the bed and wheeling it away.

Additional Protection in City Hospital

The fire-signal system in this building is designed so as to adapt it to the improved conditions. The signals operate only in the one fire unit in which the fire occurs and in no other. Every signal is nevertheless transmitted automatically to the central office and the shops, dormitories and other service buildings, apprising them of the fire and its location and thus summoning assistance without delay. A city fire department call box is located in the central office, through which the day or night operator can instantly relay the call to the fire department. In the hospital wards the signals consist of red lights and tappers that do not alarm the patients, while in the service and administrative units the signals are single-stroke gongs of suitable sizes to fulfill the requirements. In the annex units 18 and 19 two new stairways, one on each side of the firewall, had to be introduced at each end of the building.

Numerous details required attention so as to perfect the safety scheme. In many cases water, steam and sewer pipes passed through openings in basements, cellars and attics that required firedoor protection. When the pipes were at the top of the openings, permanent brick transoms 8 in. thick and supported on channels were built in the upper part of the openings and the rest protected by firedoors. Similarly, sills were haised when pipes occurred at the bottom of the openings.

Occasionally, wood floor and roof beams were continuous through or over walls that were to be utilized as firewalls. Such timbers are to be cut at the wall and the ends separated by not less than 6 in. of cement mortar rammed so as to isolate thoroughly the woodwork on each side. When sufficient bearing is not remaining, steel stirrups shall be supplied.

All wood beams supported by firewalls are required to be beveled so as to be self-releasing in case of fire on either side of the wall. Dormer windows within 10 ft. of a firewall and within 2 ft. of the face of the exterior walls shall be protected by sheet-metal covering and fireproof window frames, sash and wire glass.

Typical Protection in Other Buildings

Another typical example of the firewall treatment is in the Infants Hospital Building on Randalls Island. This is a brick structure three stories and basement high, with wood interior and wood roof covered with slate in the mansard portions and with tar and felt in the flat portions. It is used as an administration building and a dormitory for feeble-minded boys.

In this building certain existing walls were utilized as firewalls. These were found to be more desirable for the purpose than walls coinciding with the projections

above the roof. An interesting problem was presented by a long wooden piazza with wood roof extending along the entire north side of the building east of the west wing. The piazza extended around the ends of all firewalls. The best solution was found to lie in fireproofing 20-ft. sections of the piazza adjacent to the ends of the firewalls. In the case of the dormitories for aged males and females in the City Home group, Blackwells Island, where similar three-story wooden balconies skirted the firewalls, the latter were extended through the balconies.

In the Farm Colony, Staten Island, four large new dormitories of nonfireproof construction, with stone walls, were divided into approximately two equal parts by new firewalls; but only in one other building of the 64 treated by the firewall principle (five in all) were new firewalls required. The appearance of the old and new firewalls above the roof may be noted in Fig. 2.

The views of interiors in Figs. 3 and 4 are typical of the appearance of the firedoors cut through the firewalls for horizontal exits.

Studies of Dredged Drainage Ditches Before and After Clearing*

By Charles E. Ramser†

SYNOPSIS—Carefully made hydraulic observations on the flow in dredged ditches to determine value of n under different conditions, with comparisons of values before and after clearing.

The following described experiments were made for the purpose of determining the value of the roughness coefficient n in Kutter's formula, for use in the design of drainage channels.

In these experiments, a straight and practically uniform course of channel was selected near each gaging section, so that no surface water and very little ground water entered the channel along the course. The slope of the water surface was determined by vertical measurements made down to the surface of the water from permanently set reference points. These reference points were placed on arms extending horizontally from vertical posts set firmly in the ground at each end of the course. Cross-sections of each channel were measured at intervals of 100 ft., from which the average values of the cross-sectional areas and hydraulic radii were determined for the course.

Slope and discharge measurements were made for the determination of the value of n for two dredged drainage channels—Mud and Old Town Creeks—near Tupelo, Miss., during the years 1913 and 1914.

An experiment for determining the effect upon the flow due to the clearing of Old Town channel was conducted.

*Condensed from a report by the author on Runoff Investigations and Determination of the Roughness Coefficient, n of Kutter's Formula, made in Lee County, Mississippi.

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FIGS. 1 TO 4. VIEWS OF OLD TOWN CREEK, LEE COUNTY, MISS., BEFORE AND AFTER CLEARING

Above course of slope measurements (1) before and (2) after clearing. On course of slope measurements (3) before and (4) after clearing

No clearing was done for the measurements made during 1913. One bank of the channel and part of the bottom was practically covered with small saplings, brush and cane and was quite irregular. The other bank was comparatively smooth and uniform with occasional growths of vegetation.

For the measurements during 1914, all brush, vegetation and other obstructions were cleared from the channel for 500 ft. above the upper end of the course and the same distance below the lower end. The soil in the channel is a solid black to yellow wax-like clay which is hard and erodes very little. The slope of the left bank is quite regular while that of the right bank is extremely irregular, which is due to the growth of vegetation causing the bank to erode unevenly. The views, Figs. 1, 2, 3 and 4, of Old Town Creek afford a good idea of the conditions existing in the channel before and after clearing.

FIG. 5. MUD CREEK, ALONG COURSE OF SLOPE MEASUREMENTS

Table 1 shows that the values of n for uncleared condition of channel of Old Town Creek range from 0.042 to 0.054 and between 0.0282 to 0.034 for cleared channel.

It is obvious from the values of n obtained before and after clearing that the efficiency of a canal is greatly decreased by permitting the growth of vegetation in the channel. For example, if n be taken as 0.045 before clearing and 0.03 after clearing, the discharge for Old Town Creek, at bank-full stage and for a slope of 0.0003, would be 590 and 858 sec.-ft. respectively, the latter discharge being 45.5% greater than the former.

It should not be inferred that clearing the channel for a short course increased the discharge for the course by the above amount, for only the clearing of the whole canal would accomplish this. However, the increased efficiency of the cleared part reduces the fall through that part and thereby increases the hydraulic gradient through the uncleared parts, thus tending to increase the efficiency and the discharge of the whole canal according to the length cleared.

A good idea of the condition and regularity of Mud Creek can be obtained from Fig. 5. The soil in the channel is a sandy wax-like clay which erodes very easily. This is a comparatively new channel, the ditch having been completed in January, 1913, and these measurements were made during the first part of 1914. Although some erosion has occurred, the ditch has retained its original uniform slope and comparatively uniform cross-sectional area. Table 2 shows the values of n obtained for Mud Creek.

TABLE 1. HYDRAULIC ELEMENTS OF OLD TOWN CREEK
Length of slope course, 1,224 ft. Channel uncleared.
Data for 1913

Maximum Average Depth, Ft.	Surface Width, Ft.	Slope	Mean Hydraulic Radius	Mean Velocity, Ft. per Sec.	Average Cross-Section Area, Sq. Ft.	c	n
5.4	21.9	0.000518	2.90	1.25	76.2	32.8	0.0540
5.8	22.0	0.000513	3.12	1.47	85.5	36.9	0.0485
6.7	25.9	0.000444	3.55	1.66	108.2	41.8	0.0450
10.8	34.9	0.000388	5.30	2.16	231.8	47.9	0.0433
11.7	35.5	0.000445	5.78	2.22	261.0	43.8	0.0480
12.6	39.0	0.000452	5.95	2.26	298.2	43.5	0.0490
13.6	45.2	0.000375	6.06	2.41	341.5	50.5	0.0420
1914 (Channel Cleared)							
6.6	26.4	0.000271	3.37	1.73	107.0	57.4	0.0314
6.7	26.5	0.000305	3.42	1.98	110.2	61.4	0.0295
7.1	27.5	0.000290	3.53	2.00	120.0	62.3	0.0294
7.1	27.6	0.000279	3.58	2.02	120.0	·64.1	0.0286
7.4	28.0	0.000267	3.69	2.05	127.0	65.5	0.0282
8.1	29.8	0.000271	3.95	2.18	142.3	66.6	0.0282
11.9	37.5	0.000346	5.70	2.68	265.0	60.3	0.0340
12.4	39.7	0.000268	5.95	2.76	295.5	69.3	0.0295
12.7	41 0	0.000346	6.05	2.87	307.4	63.0	0.0328

TABLE 2. HYDRAULIC ELEMENTS OF MUD CREEK
Length of slope course, 1,194 ft. Data for 1914

Maximum Average Depth, Ft.	Surface Width, Ft.	Slope	Mean Hydraulic Radius	Mean Velocity, Ft. per Sec.	Average Cross-Section Area, Sq. Ft.	c	n
2.6	18.5	0.000300	1.8	1.37	40.0	59.0	0.0264
2.8	19.3	0.000305	1.9	1.44	43.0	59.8	0.0264
2.9	19.5	0.000305	1.9	1.50	43.2	62.3	0.0255
3.2	20.5	0.000310	2.1	1.57	47.7	61.5	0.0262
3.8	22.0	0.000301	2.3	2.00	57.5	79.8	0.0221
4.0	22.6	0.000349	2.5	2.05	61.0	69.3	0.0246
4.1	22.8	0.000336	2.6	2.08	62.6	70.5	0.0244
4.9	24.7	0.000321	2.9	2.19	88.0	72.3	0.0243
4.95	24.8	0.000349	2.9	2.25	88.5	70.7	0.0247
5.0	24.9	0.000340	3.0	2.26	90.0	71.0	0.0248
9.9	32.5	0.000364	5.3	3.39	225.0	77.2	0.0260
10.65	34.5	0.000378	5.6	3.58	252.5	78.0	0.0254
10.70	34.5	0.000393	5.6	3.60	254.0	76.8	0.0260

It is seen that the values of n obtained for Mud Creek are lower than those for Old Town Creek. This is due to the facts that Mud Creek is a more recently constructed channel and the bottom slope and cross-sectional area are more uniform throughout the course than for Old Town Creek.

It appears that the proper value of n for ditches similar to Mud Creek is about 0.025, which means that the banks and sides should be fairly regular and free from any form of obstruction to flow, and the slope and cross-sectional area practically uniform. These conditions generally obtain only in new ditches, and it would therefore not be wise to use a coefficient as low as 0.025 in the design of drainage ditches, since the efficiency of a ditch generally decreases with age. It is recommended that in the design of such ditches the value of n be taken as 0.030, the approximate value obtained for Old Town Creek; but if it is not expected that the channel will be kept cleared of vegetation and other obstructions, a value as high as 0.040 or 0.045 should be used.

Quick Transit Through the Panama Canal was accomplished on Dec. 17 by the steamship "Acajutla" of the Pacific Steam Navigation Co. It entered the outer end of the buoyed channel at Balboa at 12:15 p.m. and dropped anchor in the harbor at Cristobal at 6:35 p.m., making the transit in 6 hours and 20 minutes, which is 5 minutes less than the best previous record. In the minority report of the Board of Consulting Engineers for the Panama Canal in 1906, comparative estimates were made of the time of passage through a lock canal and through a sea-level canal. The time of passage through the lock canal was then estimated at 9½ to 10 hours for a large freight steamer of 32 ft. draft. Results now obtained in the movement of ships through the canal show that the estimates made by the consulting engineers ten years ago were fairly accurate and at the same time conservative in their claims for the lock canal.

Engineering Literature

New Hydraulic Tables for Conduits

REVIEWED BY ROBERT E. HORTON*

FLOW OF WATER UNDER PRESSURE THROUGH CLEAN CLOSED PIPES: Tabulated Data with Explanatory Notes—By George T. Prince, C. E., M. Am. Soc. C. E. New York: D. Van Nostrand Co. Cloth; 4x7 in.; pp. v + 149; illustrated. $2.

This book contains a set of tables showing the discharge in pipes of various diameters for different friction heads and velocities. In this respect it covers the same ground as the tables by Edmund B. Weston, based on the D'Arcy formula, and the tables of Williams and Hazen, based on their own formula. It differs, however, from these and other earlier tables of friction head in pipes in some very marked respects. The fall in feet per thousand is used as the argument or independent variable instead of using the discharge or velocity, as has been done in most similar tables hitherto published. Which arrangement is better depends upon the problem to be solved. If the friction head for a given discharge is required, then the arrangement formerly used is most convenient. Probably, however, it is true that in more than half of the cases arising in water-works practice, especially conduit lines, the problem is to determine the size of pipe for a given capacity, or the capacity for a given size of pipe where the friction head is fixed in advance. For such problems the arrangement used by Prince is preferable.

Instead of giving the values of discharge in friction head for different sizes of pipe as determined from a single formula, as has generally been done in similar tables heretofore, this book contains the discharge for each size of pipe and for a series of different friction heads, as determined by five different formulas or methods, which include Kutter's formula with a coefficient of roughness 0.010, the D'Arcy formula, Lampe's formula, Fanning's formula and coefficients for friction head in pipes, and the formula $H_f = mv^{1.73}$. There are thus five entries under each size of pipe and for each friction head. Usually, the engineer engaged in the design of an important water-supply conduit desires to compare the results as to friction and discharge obtained by different formulas. In so far as such a comparison involves the five formulas referred to, the work is already done in a very neat and satisfactory manner in these tables. The tables are also more complete as to sizes of pipes than most others hitherto presented, as they cover a range of pipes from 4 to 48 in. in diameter by increments of 2 in., and from 48 to 120 in. in diameter by increments of 6 in.

In addition to the friction head and velocity, the discharge is given in each case in terms of cubic feet per second, United States gallons per minute, and millions of gallons per 24 hr. The coefficient C in the Chezy formula, which would give the same result as derived from each of the different formulas used in preparing the tables, is also given for the convenience of engineers who prefer to work from the coefficient C rather than from the coefficient of roughness in applying the Kutter and Chezy formulas.

The book had its inception in studies made by the author on the flow in continuous wood-stave pipe, and the tables seem to have been prepared primarily with reference to wood-stave rather than cast-iron pipe. The author adopts the coefficient of roughness 0.010 in the Kutter formula as applicable to wood-stave pipe. While this value of n is often obtained in new wood-stave pipe in excellent condition, it is a lower figure than many engineers would adopt as a basis of design.

D'Arcy's, Fanning's and Lampe's formulas have been considerably used for cast-iron pipe, but not generally for wood-stave pipe, and there are a number of recent formulas for calculating the flow and friction head in wood-stave pipe, including those of Tutton, Noble, Moritz and Scobey, which are not referred to in this book.

It appears that no examples are given illustrating the use of the tables. Such tables are commonly employed for the solution of problems involving the flow in compound or branching mains, and illustrations of their application for these problems would be generally helpful.

The introductory chapter contains some discussion of formulas used and of the development of friction-head and pipe-flow formulas. It is accompanied by an elementary statement of the methods of straight-line plotting of experimental data on logarithmic paper.

The author takes the position, which appears wholly logical, that no general rules can be laid down for deterioration in pipe capacity with increased age, inasmuch as the deterioration is largely a function of the character of the water and depends as much, or more, on the amount of suspended matter and hardness of the water as upon the age of the pipe itself. He gives, however, a table of average values of capacity-depreciation factors, based on experience in a western city.

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Municipal Engineering Gaps Filled

MUNICIPAL ENGINEERING PRACTICE—By A. Prescott Folwell. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xi + 422; 113 illustrations. $3.50 net.

By presenting a fair amount of the theory and a considerable wealth of the detailed practice of certain fields of municipal engineering the author has filled some gaps in the recent literature of the subject. Leaving water-supply, sewerage and paving nearly alone, as well taken care of in existing books, the author traverses nearly all the other lines of work with which the municipal engineer has occasion to deal.

After taking up such fundamental data as population, Mr. Folwell reviews the various elements of the city plan. This section is an epitome of city planning, chiefly from the engineering viewpoint. Then follow eight chapters dealing with as many divisions of city engineering and allied work. These have to do with various details of street surface other than paving, such as sidewalks, curbs,

gutters and street-railway tracks; bridges, viaducts and the treatment of water courses and waterfronts; city surveying; street lights, street signs and house numbers; the sprinkling and cleaning of streets; the collection and disposal of garbage and other city refuse; public markets, comfort stations and baths; and parks, cemeteries and shade trees.

The book contains much that is well designed to interest and assist various councilmanic committees and heads of municipal administrative departments, besides being particularly well adapted to the needs of city and town engineering staffs. The illustrations are particularly commendable, both halftones and line drawings, as aids to the text and often as driving home a story of their own.

Traffic Through Panama Canal

THE PANAMA CANAL AND COMMERCE—By Emory R. Johnson, Ph.D., Sc. D., Professor of Transportation and Commerce, University of Pennsylvania; Member Isthmian Canal Commission, 1899-1904; Special Commissioner of Panama Canal Traffic and Tolls, 1911-13. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. 296; illustrated. $2 net.

There is no higher authority on the subject covered by this book than Professor Johnson. As a member of the Isthmian Canal Commission of 1899-1904, he had charge of the investigation to determine the probable commerce that would seek the canal after completion. A decade later he was made special commissioner on Panama Canal traffic and tolls, and it was under his direction that the present system of tonnage measurement and tolls was worked out. An idea of the scope of the book may be obtained from the titles of some of the principal chapters: Why the Canal Was Built; The Canal and Freight Rates; The Canal and Domestic Trade and Industry of the United States; The Canal and the American Marine; Competition of the Suez and Panama Routes; Fuel Supplies and Costs via the Panama Canal and Alternative Routes; The Panama Canal Tolls; What Happened When the Slides Closed the Canal.

The revolutionary situation in ocean traffic that has existed ever since the canal opened has made more or less problematical many questions as to the volume and character of traffic through the canal, which in the ordinary course of events would now be well settled. Added to this has been the disorganization of traffic through the closing of the canal by slides for about seven months during its second year of operation.

The author believes that the canal has already been of large benefit to the western part of the United States and Canada, but the extent to which the canal will stimulate business between the United States and countries on the western side of the Pacific he considers still uncertain.

In the chapter on the competition of the Suez and Panama routes the author quotes the result of an extended investigation made by M. Casimir-Perier as to the loss of traffic that the Suez Canal would experience when the Panama Canal was opened to traffic. The conclusion reached was that the loss would probably not amount to over 300,000 tons per annum. This is a very small percentage of the Suez Canal traffic, which amounted to 16,500,000 tons in 1910 when the investigation was made. While Professor Johnson thinks this estimate too small, he holds that the two canals are to be regarded as supplementary routes quite as much as competitive rivals. He thinks that the stimulus to industrial progress and international trade resulting from the Panama Canal will eventually cause the Suez Canal business to be larger than it would have been had the Panama Canal not been built.

One very important factor in the future of the Panama Canal as a trade route is the cost of steamship fuel. The author believes that owing to the Panama Canal being located comparatively near the chief coal-shipping ports in the United States, the price of fuel will probably rule lower there than on the sailing routes through the Mediterranean or around the Cape of Good Hope.

Special interest attaches to the chapters on the Panama tolls and the Panama tonnage rules, for which the author was responsible. It will be remembered that after the canal had been in operation for some months it became necessary to make refunds to a considerable number of the vessels that had used the canal, because the net registered tonnage fixed by United States Government rules for the measurement of vessels under the interpretation of the Commissioner of Navigation gave lower tonnages on some vessels than the Panama tonnage rules worked out by Professor Johnson. It is at present necessary for the canal officers at Panama to determine for each vessel whether its tonnage by United States measurements will be less than its tonnage measured by the Panama rules. A bill to remedy this situation is pending in the House of Representatives.

The forecast of business made prior to the completion of the canal indicated that the net tonnage of shipping would amount to about 10,500,000 tons per annum during the first years of operation, with an increase at the rate of at least 60% in the first decade, so that it would reach 17,000,000 by 1925. With a traffic of this volume and the present rates of toll it was computed that the revenues at the end of the decade would be sufficient to pay the canal operating expenses, maintenance and interest charges on its cost. The expected volume of traffic has not materialized, due to the slides and the war, but the author believes that, when normal international and domestic trade conditions are reëstablished, his forecast as to its commercial importance will be justified.

Weight of Steel Shapes

ELLIOTT'S WEIGHTS OF STEEL, for Engineers, Architects, Contractors, Builders, Steel Manufacturers and all Users of Rolled Steel—A set of tables that enable the user to tell instantly and without calculation of any kind, except an occasional bit of simple addition, the weight of any given piece of rolled or drawn-steel. Computed by Thomas J. Elliott. Cleveland, Ohio: The Penton Publishing Co. Leather; 6x9 in.; pp. 662; thumb index. $20.

The purpose of this collection of tables is to enable one to find the weight of a single piece of any section of rolled steel without having to perform the operation of multiplication. Having found the weight of a lineal foot of any section of rolled steel or rolled plate from the "Shape Books" of the steel manufacturers, all that is necessary to determine the total weight is to turn to the page corresponding to the unit weight of the shape. Here will be found the weights of $\frac{1}{16}$ in. to 60 ft. in length of this particular shape.

The tables in this book give weights of $\frac{1}{16}$ in. to 60 ft. in length of rolled steel weighing 1 to 300 lb. per lin.ft., and the weights of the same lengths weighing 0.01 to 0.99 lb. per lin.ft., and shafting and reinforcing-rod tables. The comprehensive stub index makes the right table easy to find, while the simple arrangement of the data makes the tables easy to use.

Mortality Tables and Their Making

Reviewed by G. C. Whipple*

MORTALITY LAWS AND STATISTICS By Robert Henderson, Actuary of the Equitable Life Assurance Society of the United States. New York: John Wiley & Sons. [Mathematical Monographs; edited by Mansfield Merriman and Robert S. Woodward.] Cloth; 6x9 in.; pp. v + 111; illustrated. $1.25 net.

The interest in life tables is being revived. This is partly due to recent writings of actuaries of life-insurance companies, but also to the fact that public health officials and the United States Census Bureau itself are taking up the matter. The advantage of life tables over other forms of expression of mortality statistics is that they are more readily visualized by the average person than are the specific death rates upon which the life tables are based.

Mr. Henderson, who is the actuary of the Equitable Life Assurance Society, has given in this work a description of what mortality tables are and how they are prepared. The methods used are necessarily complicated, and this book is not for the average reader. It will be found interesting and valuable, however, to all who desire to look below the surface of vital statistics and to use the data in the most effective way.

The book contains the principal experience tables that have been issued since the time of Halley, the astronomer, who was the first statistician to use this form of expression. The author calls attention to some of the popular misunderstandings in regard to mortality tables and in particular to the fact that tables showing "expectations of life" are not used as a basis of computing the premiums of life insurance. The work is confined to the mortality tables and does not enter upon their combination with the theory of compound interest. The book is No. 15 of the series of mathematical monographs noted in the title heading.

New Formulas for Flow of Water

THE FLOW OF WATER IN WOOD-STAVE PIPE—By Fred C. Scobey, Irrigation Engineer, with Discussion by Gardner S. Williams, Theron A. Noble, D. C. Henny, E. A. Moritz, E. W. Schoder, L. M. Hoskins. Washington, D. C.: United States Department of Agriculture, Office of Public Roads and Rural Engineering, Logan Waller Page, Director. Bulletin 376. Paper; 6x9 in.; pp. 96; illustrated. 25c. per copy from Superintendent of Documents.

Mr. Scobey describes in this professional paper of the Office of Public Roads and Rural Engineering the development of a new exponential formula for flow of water in wood-stave pipes. His studies convinced him that this type of expression is more adapted to pipes running full under pressure than the Kutter formula. These new equations,

$$H = \frac{7.68\,V^{1.8}}{d^{1.17}} = \frac{0.419\,V^{1.8}}{D^{1.17}}$$

$$V = 1.62D^{0.65}H^{0.555}$$

$$Q = 1.272D^{2.65}H^{0.555}$$

follow the form of the Moritz formulas, but have different constants and exponents. The Moritz formulas were based on one man's experiments with a limited range of pipe diameters. The new expressions are based on all the wood-stave pipe experiments on record and, in addition, on the results of an extensive series of new experiments.

Descriptions of tests, interpretation of data and the use of the expressions are set forth in this volume. There are a logarithmic diagram and a set of tables, based on these formulas, for designing pipe. The only connection between these studies and their use for other pipe lines lies in the statement that "wood-pipe will convey 15% more water than a 10-year-old cast-iron pipe, or a new riveted pipe, and about 25% more than a 20-year-old cast-iron pipe or a 10-year-old riveted pipe."

Appended to the main text are criticisms of the advance proofs by Williams, Noble, Henny, Moritz, Schoder and Hoskins.

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Cost Keeping by a Cost Accountant

COST ACCOUNTING AND BURDEN APPLICATION—By Clinton H. Scovell, C. P. A., Assoc. Am. Soc. M. E. New York: D. Appleton & Co. Cloth; 6x8 in.; pp. xiv + 328. $2 net.

The principles and elements of cost are treated by Mr. Scovell rather than any specific system of cost keeping. The determination and application of overhead charges or burden are given a prominent place. The five methods of applying burden are: Percentage on wages, percentage on labor and material, man-hour rates, old-machine rate, new-machine rate. The first three methods are well known. The old-machine rate is rarely used, but the new-machine rate, for reasons given at length, is coming to be accepted as the best to use under conditions to which it applies. This method contemplates the analysis of all the factors making up the manufacturing burden, in order that the proper overhead may be known for each department and for each production center in each department. The total burden divided by the standard number of operating hours in a year gives the machine-hour rate, "which is used to charge burden to the cost of orders in proportion to the length of time which each order uses the manufacturing facilities afforded by its production center."

Material and material cost with reference to the practice of machine shops are discussed in Chapter III. The succeeding chapter is on labor costs. The later chapters deal with cost accounting for special industries. The chapter on paper manufacturing costs is especially pertinent at this time of extremely high prices for that commodity. Another chapter discusses the cost of power and steam with special regard to distributing the cost correctly. The chapter on the Cost Department emphasizes the fact that the value of such an organization does not consist alone in the cost-*finding,* but also in cost-*accounting,* a work much broader and much more valuable to the management.

The author states that every method and device mentioned in the book is in successful operation in some progressive industrial establishment. According to the credit given, the subject matter of the several departments of the book has been carefully checked by competent men.

Settling Industrial Disputes

MEDIATION, INVESTIGATION AND ARBITRATION IN INDUSTRIAL DISPUTES—By George E. Barnett, Ph. D., Professor of Statistics, Johns Hopkins University, and David A. McCabe, Ph. D., Assistant Professor of Economics, Princeton University. New York: D. Appleton Co. Cloth; 5x8 in.; pp. viii + 209. $1.25.

Settling disputes between capital and labor is becoming an increasingly trying task and one calling for skill, patience, courtesy and a knowledge of both human nature and national economic conditions by the arbitrators on both sides. Industrial belligerence will no doubt continue

for many years to come, and any light of experience that can be shed upon the question should be taken advantage of by interested parties. This particular study of mediation, investigation and arbitration is based on a report, submitted in June, 1916, by the authors, to the Commission on Industrial Relations. The book is divided into three parts. The first deals particularly with the title subject. The second discusses proposed new agencies and a suggested plan of a national system of mediation, investigation and arbitration. The third part contains extracts from the report of the commission.

Advances in Paint Technology

REVIEWED BY ROBERT JOB*

THE CHEMISTRY AND TECHNOLOGY OF PAINTS—By Maximilian Toch, author of "Materials for Permanent Painting." New York: D. Van Nostrand Co. Second revised edition. Cloth; 6x9 in.; pp. 366; 83 photomicrographic plates and other illustrations. $4 net.

The original edition of this work was published in 1907 with 161 pages, compared with 353 pages in the present edition. The additions and changes are due to advances in the production of new pigments and paints as well as in methods of manufacture. The same general arrangement of the book is followed as in the first edition, but so much new material has been added that the new volume will be found useful even by those who are familiar with the other.

During the past decade there have been radical changes in the paint industry, and pigments and oils which 10 years ago were little known by the general public are far better understood, due in part to the legal requirements as to labels. There is also today a much clearer understanding by consumers as to the use of the so-called "inert" pigments or "extenders," and it is quite generally known that their presence in proper proportions is not only permissible, but necessary and highly desirable if the best results are desired. The various types of these pigments are discussed in detail. Descriptions are given of white pigments, including zinc-lead, basic sulphates, lithopone, etc. Lithopone is a valuable pigment when used under certain conditions, but it might not be amiss to mention its failure in paints exposed to weathering, as shown in the tests made at Atlantic City by the American Society for Testing Materials.

The use of red lead for the priming coat upon structural steel is well known everywhere, but it is not so clearly understood that other paints can readily be obtained which are equally serviceable and which are far easier of application. Mention is also made of various combinations that are made with red lead to prevent rapid settling in the can and to enable the average painter to secure a more even coating than is frequently the case in ordinary practice when using pure red-lead paint.

Fortunately for the consumer, some of the most durable results in painting can be secured with the least expensive materials and by correct use of inert materials. Oxide of iron is an excellent protective pigment when properly ground, and the same statement may be made of many of the less expensive pigments. As a result the purchase of paint materials under specifications and competitive bidding has increased widely and is a common practice today. It frequently results in radical saving to the consumer in money cost, and frequently also with decided improvement in service.

Separate chapters follow upon colored pigments—red, brown, yellow, blue, green and black respectively. Helpful information is given as to various combinations that cannot be used successfully and the conditions under which permanency of color can be expected.

It is not generally appreciated that a pigment often gives much better service when diluted with suitable extenders, such as clay, silex, abestine, etc. For example, a pure graphite paint is unnecessarily expensive; and also better service results can be obtained by addition of considerable proportions of extenders or "fillers," such as those mentioned above, using proper precautions to have the paint finely ground and in proper physical condition.

Formulas are given for paints for special purposes and also the difference in the proportions of oil and volatile matter for priming coat for subsequent coats.

Soya bean oil and especially china-wood oil are used very considerably in paints today; and a useful summary of information is given regarding these and other oils and their properties, with methods for testing their purity and also a description of turpentine and the various substitutes for the latter which have been developed in recent years (some of them with very satisfactory results). Cobalt driers are also a recent development of much value for certain purposes.

Methods for analysis of pigments and of oils are given in detail and will be of service to the paint chemist, also tables of specific gravities, etc.

The text is quite free from typographical errors, although upon page 139 the percentage of water in gypsum is stated as 48.85%—evidently intended to be 18.84%.

The reviewer believes that the book will be of interest to both manufacturers and consumers of paints.

*Vice-President, Milton Hersey Co., Ltd., Industrial Chemists, Metallurgists, Consulting and Mining Engineers, Montreal, Que., Winnipeg, Man., and New York City.

Useful Park Text and Handsome Views

PARKS: Their Design, Equipment and Use—By George Burnap, Landscape Architect of Public Buildings and Grounds, Washington, D. C.; Lecturer in Landscape Design, University of Pennsylvania. With an Introduction by Richard B. Watrous. Philadelphia: J. B. Lippincott Co. Cloth; 7x10 in.; pp. 328; colored frontispiece, 163 halftones and four diagrams. $5.

There has long been need for a book on parks, written primarily for the benefit of the layman park official and the student, but yet with the knowledge and insight of the professional park designer and superintendent. Mr. Burnap's book goes far toward meeting this need.

After general chapters on park design, the various classes of parks are treated, and many of the troublesome questions relating to playgrounds in parks are answered. Monuments and architecture in parks are next considered, after which follow interesting and instructive chapters on water as a decorative feature and the planting design of parks, including in the latter the relation of administration to planting design. There is a useful chapter on seats in parks, a chapter on various park utilities and one on the disposition of flowers in parks.

The volume is profusely illustrated with well-chosen and finely executed views, of which there is one opposite each page. These views fill two-thirds of the height of the page, leaving the remaining third for a "boxed" title and subtitle, the "box" corresponding to the heavy hatched border around the halftone. The arrangement is æsthetically pleasing, but some of the subtitles are ob-

securely worded, and the illustrations and their explanations are, as a rule, very poorly correlated with the text. In fact, an engraving opposite practically every page of text, but more often than otherwise not directly connected with the latter, is sometimes distracting to the reader. The text contains general references to the illustrations, but no page references. There would have been a gain in utility and little if any loss æsthetically if the illustrations pertinent to each chapter had been placed at the chapter end. This change in arrangement, with more care in the wording of the subtitles to the views, would have made the illustrations go much farther than they do in telling a unique story of their own.

If the subject matter of the text seems inadequate to any readers of this notice, they should take cognizance of the fact that three companion volumes are in preparation—on "Gardens," "Pictorial Planting" and "Landscape Art." It is partly with this in view that we have ventured to make the foregoing comments on the illustrations in the volume now under consideration. If the author and publishers feel that the series, as contributions to art literature, demand the rather sumptuous style of the present volume, it is to be hoped that they may eventually find it practicable to issue a more utilitarian edition. Bulk, weight and price could be cut nearly, if not quite, in half without sacrifice of utility, making the volume handier and bringing it within the reach of a much larger circle of readers.

Life Sketches of Great Mathematicians

TEN BRITISH MATHEMATICIANS—By Alexander MacFarlane. New York: John Wiley & Sons, Inc. [Mathematical Monographs; edited by Mansfield Merriman and Robert S. Woodward.] Cloth; 6x9 in.; pp. 150. $1.25.

There are at least two types of mathematical mentality—that which cannot perform the simple mechanical processes without a strong likelihood of error, yet can work out on paper the most intricate equation, and the one that can extract cube root without using a pencil. The ten pure mathematicians whose careers are sketched by Dr. McFarlane, now deceased, include prodigies of both types. The period covered is from 1791 to 1884.

An especially interesting characteristic of great mathematicians is their almost universal love of poetry. Clifford is said to have remarked that mathematics and poetry are sisters, and he himself helped to justify his statement by writing at least one very creditable poem. William Rowan Hamilton also was a poet, and J. J. Sylvester wrote a book entitled "The Laws of Verse." He must have felt some pride in this work, because he signed one of his mathematical communications, "J. J. Sylvester, Author of 'The Laws of Verse'."

Poetry is by no means the only mental relaxation of the mathematician. Clifford once devoted 12 hours to reviewing a book based on the following anagram:

$$A^8C^3DE^{12}F^4GH^6L^3M^3N^5O^6PR^4S^5T^{14}U^6V^2WXY^2$$

This alphabetical series is translated, "Thoughts conceived to affect the matter of another universe simultaneously with this may explain a future state."

Hamilton was knighted and two years later became President of the Royal Irish Academy, but his highest title to fame rests on his work on quaternions. At the time of his death the "Elements of Quaternions" was finished with the exception of one chapter. The book was published, only 500 copies being printed. In consequence it soon became a rare book, and as much as $35 has been paid for a copy.

Thomas Penyngton Kirkman, ordained a minister, in addition to important mathematical work devoted some time toward bringing "the memory of the vocal organs and the ear to the assistance of the reasoning faculties," writing a book on the subject. It was he who published in the "Ladies' and Gentlemen's Diary" in 1850 the famous problem of the 15 school girls who walked out of school three abreast, the problem being to determine how many arrangements can be made so that no two will be abreast more than once. The answer is 35 and may be proved by those equipped for such work.

Dr. MacFarlane's book, which is a collection of lectures delivered by him at Lehigh University, should appeal to all students of human nature. It is, however, of more special interest, because not only are the personalities drawn, but the work and achievements of these men are presented and discussed in considerable detail. In addition to the names mentioned in the foregoing the careers of the following mathematicians are sketched: George Peacock, Augustus DeMorgan, George Boole, Arthur Cayley, Henry John, Stephen Smith and Isaac Todhunter.

Lectures on Alternating Currents

ALTERNATING CURRENTS—By Carl Edward Magnusson, M. S., Ph. D. E. E., Professor of Electrical Engineering, University of Washington; Fellow, Am. Inst. E. E. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xv + 525; 475 illustrations. $4 net.

Another addition has been made to the already long list of electrical teaching texts that are primarily lecture notes arranged to satisfy the specific needs of specific institutions. By stating that the book, even though having 500 odd pages, covers only fundamentals, the scope is indicated. The treatment is of theory, not heavily loaded with field and shop practicalities, and aims to help students to gain an idea of internal reactions and to handle certain physical facts in mathematical shorthand. Transformers are taken up after voltage generation and. circuit properties. This is followed by motors, generators, converters, insulation, polyphase power, long-distance transmission. The chief feature of originality lies in pushing the study of transmission lines farther than common with undergraduates.

Guide to the Ford Automobile

THE MODEL T FORD CAR: Its Construction, Operation and Repair—By Victor W. Page, Member of the Society of Automobile Engineers; author of "The Modern Gasoline Automobile." New York: Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. 228; 94 illustrations. $1.

The author of this book is well known as the writer of a number of thoroughly practical treatises on automobile engineering. He states that the close of 1916 will see at least 1,000,000 Ford cars of all types in use. Without doubt there has never been in the whole history of mechanical engineering a machine of equal size, complication and cost produced in such immense numbers.

The author has endeavored to give the non-technical reader an idea of the elementary mechanical principles involved in the various parts of the Ford car, and at the same time to give practical instructions governing its operation, maintenance and repair. The book has the same liberal provision of excellent illustrations that characterizes the other automobile books by the same author.

By making relatively slight changes in construction details of a nonfireproof building, its fire resistance can be greatly increased. Specific points of advice are given in the pamphlet "Structural Defects; Suggestions for Their Elimination and Protection," issued by the National Fire Protection Association. This little publication gives illustrated directions as to how and where to place fire stops. In so doing it hits at the characteristic weakness of stud framing, the commonest form of wood-frame construction. Of almost equal value, however, are pointers on safeguarding stair openings, belt and shaft openings in floors and walls, and similar special elements of fire hazard. For those who have the responsibility of keeping up and caring for wood-frame buildings, the pamphlet is a most necessary piece of educational literature.

Recent installments of the "Geological Atlas of the United States" include the "Galena-Elizabeth Folio, Illinois-Iowa" and the "Colorado Springs Folio, Colorado." (Washington, D. C.: United States Geological Survey; 25c. each.)

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ANNUAL REPORT OF THE GOVERNOR OF THE PANAMA CANAL for 1915-16—Balboa Heights, Canal Zone: Department of Operation and Maintenance. Paper; 6x9 in.; pp. xxiii + 637; illustrated, maps and diagrams.

COAL IN 1915—By C. E. Lesher. Mineral Resources of the United States, 1915, Part II. Washington, D. C.: United States Geological Survey. Paper; 6x9 in. Part A, Production; pp. 345-431; illustrated. Part B, Distribution and Consumption; pp. 433-513.

ELEMENTS OF HYDRAULICS—By S. E. Slocum, B. E., Ph.D., Professor of Applied Mathematics in the University of Cincinnati. New York: McGraw-Hill Book Co., Inc. Second edition, revised and enlarged. Cloth; 6x9 in.; pp. xvi + 329; 221 illustrations. $2.50 net.

GOVERNMENT TELEPHONES: The Experience of Manitoba, Canada—By James Mavor, Ph. D., Professor of Political Economy in the University of Toronto. New York: Moffat, Yard & Co. Cloth; 5x8 in.; pp. viii + 175. $1 net.

HYDRO-ELECTRIC POWER—By Lamar Lyndon. New York: McGraw-Hill Book Co. Cloth; 6x9 in. Vol. I, Hydraulic Development and Equipment; pp. vii + 499; 235 illustrations. $5. Vol. II, Electrical Equipment and Transmission; pp. vii + 360; 194 illustrations. $3.50.

MODERN UNDERPINNING: Development, Methods and Typical Examples—By Lazarus White, C. E., and Edmund Astley Prentis, Jr., E. M. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xii + 94; 48 illustrations. $1.50 net.

MODULES AND UNIFORM DISCHARGE DEVICES FOR IRRIGATION AND WATER-WORKS: Excerpt Minutes of Proceedings of Institution of Mechanical Engineers, October, 1916—By Hugh Munro, M. Inst. M. E. London, S. W., England: The Institution. Paper; 6x9 in.; pp. 507-555; illustrated.

THE NATIONAL CYCLOPÆDIA OF AMERICAN BIOGRAPHY. Edited by Distinguished Biographers. New York: James T. White & Co. Vol. XV. Cloth; 8x11 in.; pp. 416; 700 illustrations. $10.

NATURAL GAS IN 1915—By John D. Northrop. Mineral Resources of the United States, 1915, Part II. Washington, D. C.: United States Geological Survey. Cloth; 6x9 in.; pp. 927-1015; illustrated.

THE PHYSICO-CHEMICAL PROPERTIES OF STEEL—By C. A. Edwards, D. Sc., Professor of Metallurgy, Manchester University. London: Charles Griffin & Co. Philadelphia: J. B. Lippincott. Cloth; 6x9 in.; pp. x + 229; 181 illustrations. $3.50 net.

This book was noted briefly in the issue of Nov. 16, but inadvertently the name of the publisher was left out.

PIPE AND THE PUBLIC WELFARE—By R. C. McWane. New York: The Author, 1 Broadway. Cloth; 5x8 in.; pp. 165; illustrated. $1 net.

PRACTICAL HANDLING OF IOWA CLAYS, with Application of Ceramic Principles—By Homer F. Staley, Ceramic Engineer, and Milton F. Beecher, Formerly Assistant Ceramic Engineer. Ames, Iowa: Iowa State College of Agriculture and Mechanic Arts. Bulletin 43, Engineering Experiment Station. Paper; 6x9 in.; pp. 48; illustrated.

PRACTICAL STREET CONSTRUCTION—Planning Streets and Designing and Constructing the Details of Street Surface, Subsurface and Supersurface Structures.—New York: Municipal Journal and Engineer. Reprinted from a series of articles that appeared in "Municipal Journal," 1916. Cloth; 6x9 in.; pp. viii + 248; 151 illustrations. $2.

PROCEEDINGS OF THE FOURTH ANNUAL MEETING OF THE MONTANA INSTITUTE OF MUNICIPAL ENGINEERS, 1916—Billings, Mont.: John N. Edy, Secretary. Paper; 6x9 in.; pp. 98.

REPORT OF THE WATER CONSERVATION AND IRRIGATION COMMISSION, 1916—Sydney, Australia. Paper; 8x13 in.; pp. 128; illustrated.

REPORT ON COÖPERATION IN AMERICAN EXPORT TRADE—Washington, D. C.: Federal Trade Commission. In two parts. Paper; 6x9 in. Part I. Summary and Report; pp. xv + 387; 5 charts and 29 tables. Part II. Exhibits; pp. xxiii + 597; 15 tables.

REPORT ON IRRIGATION SURVEYS AND INSPECTIONS, 1915-16—Ottawa, Canada: Department of Interior, Irrigation Branch. Paper; 7x10 in.; pp. 86; illustrated.

REPORT ON MUNICIPAL FINANCES: Statistics of Cities and Towns of Iowa, 1915-16—Des Moines, Iowa: Frank S. Shaw, Auditor. Cloth; 6x9 in.; pp. xvi + 294.

A SERIES OF TREATISES ON THE RARE METALS: Tungsten, Molybdenum; Vanadium, Uranium—By Dr. Herman Fleck. Proceedings of the Colorado Scientific Society, Vol. XI. Denver: The Society. Paper; 6x10 in.; pp. 103-176.

SPECIFICATIONS AND TOLERANCES FOR WEIGHTS AND MEASURES AND WEIGHING AND MEASURING DEVICES, as adopted by the Eleventh Annual Conference on the Weights and Measures of the United States, Held at the Bureau of Standards, Washington, D. C., May 23-26. 1916, and Recommended by the Bureau of Standards for Adoption by the Several States—Washington, D. C.: Bureau of Standards. No. 61. Paper; 7x10 in.; pp. 44. 10c. per copy from Superintendent of Documents.

STANDARDS OF MECHANICAL FILTRATION PLANT PERFORMANCE—By Abel Wolman, Resident Engineer, Northern District, Maryland State Department of Health. [Baltimore, Md.] Reprinted from "American Journal of Public Health," Vol. 6, No. 11. Address the Author. Paper; 7x10 in.; pp. 1153-1161; illustrated.

Coefficients of efficiency are proposed for the reduction of both the total and the colon bacteria.

STEEL RAILWAY BRIDGES: Designs and Weights—By Edward C. Dilworth, Assoc. M. Am. Soc. C. E. New York: D. Van Nostrand Co. Cloth; 12x10 in.; pp. viii + 185; 105 full-page plates. $4 net.

SURFACE WATER-SUPPLY OF THE UNITED STATES, 1913: Part XI, Pacific Slope Basins in California—By Nathan C. Grover, Chief Hydraulic Engineer, H. D. McGlashan and F. F. Henshaw, District Engineers. Washington, D. C.: United States Geological Survey. Water-Supply Paper 361. Prepared in coöperation with the State of California. Paper; 6x9 in.; pp. 514; illustrated. 10c. a copy from Superintendent of Documents.

TRANSACTIONS OF THE AMERICAN CERAMIC SOCIETY, Vol. XVIII, 1916—Columbus, Ohio: The Society. Cloth; 6x9 in.; pp. 947.

THE TYPHOID TOLL—By George A. Johnson. Reprinted from the "Journal" of the American Water-Works Association, Vol. 3, Nos. 2 and 3, June and September, 1916. Paper; 6x9 in.; pp. 144; tables and diagrams.

The space is divided equally between Mr. Johnson's valuable paper before the recent convention of the association named, and oral and written discussion by many engineers and sanitarians.

UNDERGROUND LATRINES FOR MINES—By Joseph H. White. Washington, D. C.: Bureau of Mines. Technical Paper 132. Paper; 6x9 in.; pp. 23; illustrated. 10c. a copy from Superintendent of Documents.

UNDERGROUND TRANSMISSION AND DISTRIBUTION for Electric Light and Power—By E. B. Meyer, M. Am. Inst. E. E., M. Am. Soc. M. E. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. viii + 312; 156 illustrations. $3 net.

THE USE OF MUD-LADEN FLUID IN OIL AND GAS WELLS —By James O. Lewis and William F. McMurray. Washington, D. C.: United States Bureau of Mines. Bulletin 134, Petroleum Technology, 36. Paper; 6x9 in.; pp. 86; illustrated. 15c. a copy from the Superintendent of Documents.

VAPOR PRESSURES OF VARIOUS COMPOUNDS AT LOW TEMPERATURES—By G. A. Burrell and I. W. Robertson. Washington, D. C.: United States Bureau of Mines. Technical Paper 142. Paper; 6x9 in.; pp. 32; illustrated. 5c. a copy from Superintendent of Documents.

WATER POWERS OF CANADA—Reprint of a series of five monographs covering the water-power situation in Canada, prepared for distribution in connection with the exhibit of the Dominion Water Power Branch in the Canadian Pavilion at the Panama-Pacific International Exposition, San Francisco, 1915. Ottawa, Canada: Dominion Water Power Branch. Water Resources Paper No. 16. Paper; 7x10 in.; pp. 363.

WEATHERING OF COAL: An Investigation of the Coals of Canada with Reference to Their Economic Qualities, as Conducted at McGill University, Montreal, Under Authority of the Dominion Government—By J. B. Porter, E. M. Ph. D., D. Sc. Paper; 7x10 in.; x + 194; illustrated.

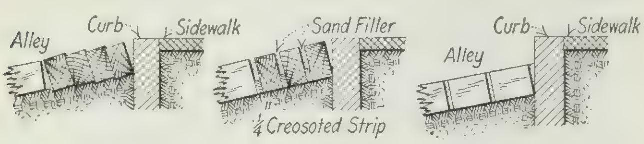
Notes from Field and Office

Paving alley returns—Blasting a rock ledge from New York Harbor—Adding five stories to an eight-story building—Concreting footings of viaduct 196 ft. high—Floating steam shovel

Paving Alley Returns in Chicago

In paving the alley returns of streets in Chicago it is now the general practice to make the top of the paving practically flush with the 6 ft. of the sidewalk next the property line and to give a straight slope at the center from the property line toward the street gutter. This method avoids the usual step at the alley and gives an almost unbroken sidewalk. The plan is not used where there is an excessive slope toward the street gutter or where there is much heavy teaming in the alleys.

Where the concave in the alley return is increased to enable its sides to be brought up to the sidewalk level, the slopes from the sidewalk to the center may be rather steep. With wood-block paving these slopes are likely to become slippery in bad weather. To prevent this condition the practice of the Board of Local Improvements is to lay the blocks parallel with the center line of the alley and with 1/4-in. open joints formed by creosoted strips. These strips are about half the depth



METHODS OF PAVING OF ALLEY RETURNS IN CHICAGO STREETS

of the block, the upper half of the joint space being filled with coarse sand. Another method employed is to lay the blocks at an angle, so that the edge of each row is 1/4 in. above that of the adjacent row, thus forming a saw-tooth surface facing the curb. Where the slopes would be too steep if the sides of the alley paving were brought up to the sidewalk level, it is now the custom to form a step of 3 to 7 in. at this place. These methods are shown in the accompanying drawing.

At some alley returns where slipperiness has caused trouble in wet and cold weather, the owners of adjacent property have nailed on the wood paving, strips of corrugated anti-slip metal (such as is used for steps). In a few cases these strips have been placed also on the street paving near the curb at crosswalks. This is done by the property owners at their own expense and apparently without permits from the Department of Public Works.

Pile-Pulling Tackle of High Power

High-powered tackle for pulling piles is used by the Louisville Gas and Electric Co. in connection with its power-house extension work at the foot of North 3rd St., Louisville, Ky. Steel sheeting spliced to make 60- to 75-ft. lengths forms the cofferdam wall for the trench for the condenser intake and discharge tunnels.

The sheeting drives very hard and requires correspondingly large pulling force to take it out. The rig built for this purpose by the company's construction department consists of a two-post frame with wire-rope pulling tackle of unusually high multiplication. The main tackle is 17-part, using 7/8-in. "Hercules" steel cable having a breaking strength of 30 tons. This cable was parted several times during the work. H. H. Fisher, Construction Superintendent, states that the pull required to take out a pile certainly exceeds 300 tons. The seventeen-part tackle is reaved through eight-sheave blocks, and for especially heavy pulling is helped by a three-sheave block and seven-part line connected between the becket and lower block. This rigging gives a travel of 120 ft. of cable to 1 ft. of main-block travel. The hoisting engine is 10x12 and geared to pull 6 tons on a single line.

The attachment to the pile is made by a pair of pin jaws fastened by one 3-in. bolt and two 3-in. pins, the three holes in the pile being in tandem. The holes usually deform enough in hard pulling to distribute the pull among the three pins. The supporting frame has 12x16-in. legs 48 ft. long, which is just sufficient for pulling a 40-ft. sheetpile clear.

Removing Coenties Reef from the East River, New York Harbor

By Edward H. Dion*

Coenties Reef, which is the name of a rock ledge about 600 ft. off the outer end of Pier 6, East River, in the Borough of Manhattan, is now in the course of removal. The United States Government appropriated sufficient money to take out material to a depth of 35 ft. below mean low water, and the City of New York has appropriated another amount, so as to increase this depth 5 ft., thus giving a 40-ft. unobstructed channel here, the adjoining waters already having this depth.

This reef is 600 ft. long and 300 ft. wide at its outermost points. The Government borings show a depth of from 25 to 32 ft. below mean low water. As none of the blasted area has been dredged, the rock formation is unknown; but it is probably gneiss. It has a covering of mud and sand on the deep area and clean rock on the shallow portion, due to scouring by the strong tides. Part of this reef was removed in 1875, to a depth of 25 ft., but broken rock left over from this job is occasionally struck.

Two of the subway tubes leading from Whitehall St., Manhattan, to Montague St., Brooklyn, now under construction, pass through this ledge. The top of the heading is at an elevation of 64 ft. below mean low water, and blasting is going on at the present time at a point

*Great Lakes Dredge and Dock Co., 17 Battery Place, New York City.

directly underneath the drill boat used by the contractor. The blasting and drilling are heard by the tunnel workers, and a very distinct shock is felt on board the drill boat when tunnel blasting is done.

The current has a velocity of from 1½ to 5 mi. per hr., and there is a tidal range of about 5.5 ft. This strong current necessitates a very secure anchorage and a close watch of the boat spuds. Moves, after the completion of a row of holes, are often delayed until slack water, because of the fear of being carried away. Traffic at this point is very heavy; consequently, the Secretary of War has restricted a buoyed area, to safeguard against accident due to the upheaval of rock, broken drill bars that project above this rock, and to protect the contractor's floating plants.

Work was started on June 9, 1916, and at the present time about three-eighths of the area has been blasted. One 5-drill frame machine is being used, operations being carried on in three 8-hr. shifts. The drill machines are Ingersoll-Rand, rock, subaqueous, known as H-64 and K-64 types. The drill bars are 55 ft. long, made up of soft-steel stock and tool-steel bits. Drilling is done to an overdepth of 5 ft.—that is, to a 45-ft. plane below mean low water. From experience derived on former rock work, this depth is thought to be sufficient to acquire the desired dredging depth to grade.

The longitudinal center line of the reef runs in a north and south line, and it was at first proposed to move the drill boat 5 ft. along this line each time, and then the entire reef would be covered in two cuts. As the current takes a sweep at this point, striking the boat broadside, the floating débris caused a lot of trouble to the drills. The force with which some timbers hit them was sufficient to cause bad bends and consequently much lost time in changing bars. Difficulty was also experienced in making moves after a row of holes had been completed, due to the water piling up on either side, depending on ebb or flood tides. After a couple of weeks' trial the position was changed to a move diagonally across, thus bringing the current on the head ends. This method has been used since with success.

In order to reduce drill-bar troubles, cast-iron pipes of decreasing diameters were attached together by steel bands forming a collapsible pipe, which can be raised when moving the boat. A cross-pipe is fitted at the lower end, to permit the drillings to wash out. The pipe is suspended from the drill frame by steel leaders, and is known as a sand pipe. Bent bars have been practically eliminated by this scheme.

After a move, the location of the drill boat is determined by shore ranges, which consist of targets and points on prominent buildings. The plotted locations have been checked by transit intersections, and the error rarely exceeds 2 ft. The sand pipes are next lowered, until they rest on the bottom.

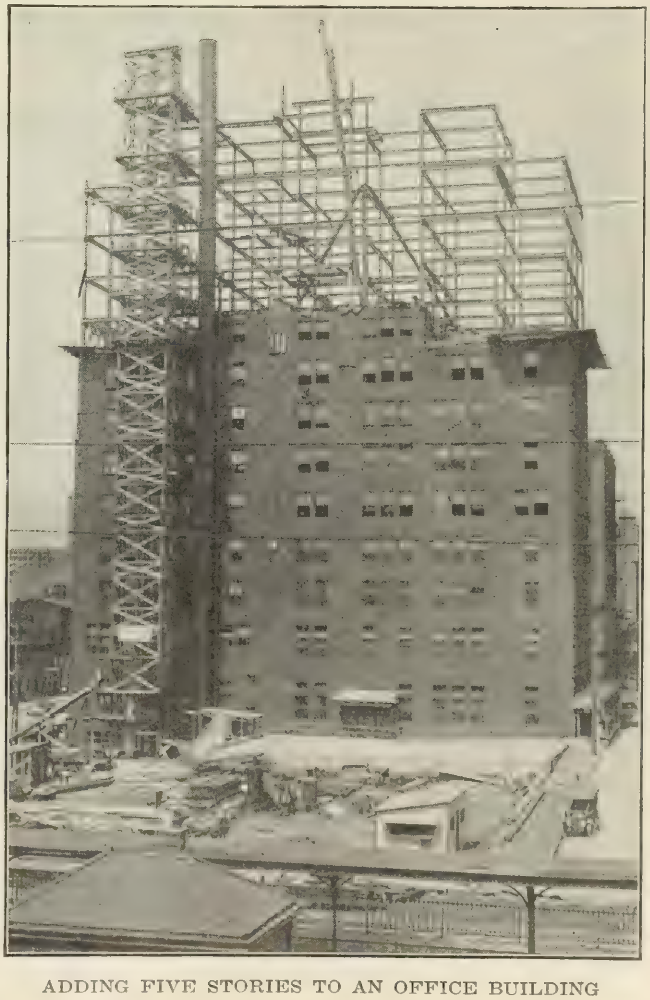
The drill bars passing through the sand pipe are started and driven to rock. The elevation is noted, and drilling continued to the 45-ft. plane. The drill is then pulled out and lowered again, this operation being repeated until the hole is clean. A charger pipe suspended from the drill frame is then lowered to the deck, where the blasters insert the dynamite. This pipe has a slit along the side, the sticks of dynamite are put in from the bottom, the last two containing the exploders. The wires are held on deck while the pipe is lowered in the sand pipe. Rammers tamp the charge to the bottom of the drilled hole, and the charger pipe is then raised. The charges are set off by machine. One hole is fired at a time, and the boat is not moved away from its position, the surface water being hardly disturbed.

Each drill frame has four holes on each move, and is capable of an overlap of one hole on either side. As the rock is very hard and subway operations demand caution, heavy charges cannot be used; therefore, holes are drilled on 5x6.3-ft. spacings. This permits 20 holes to be drilled per move. The time required to drill holes varies greatly, shallow ones often taking longer than the deepest ones. Seams are frequently struck, causing sticking, which is one of the greatest troubles encountered. Holes after completion sometimes refill with sand or with pieces of broken rock and are very troublesome to clean. From all indications, including the examination of a diver, the rock is well shattered.

The number of feet drilled by night shifts bears a very good comparison to the day work; and as the only additional cost to running the plant is lighting, an even distribution of cost of operation for 24 hr. is regarded as just.

Adding Five Stories to an Eight-Story Office Building in Pittsburgh

An extension of five stories—planned at the time the structure was erected to its original height of eight stories—has just been added to the Jones & Laughlin Steel Co. office building in Pittsburgh. In the original



ADDING FIVE STORIES TO AN OFFICE BUILDING

construction the floorbeams of the ninth floor had been put in place and used to support a temporary roof, and the columns had been provided with splices to take the future extensions. When the addition was begun, holes were cut through the roof to enter the columns, and then these holes were housed around to keep out the rain. A stiffleg derrick hoisted the steel and then erected it.

To give access to the portion of the floor lying between the stifflegs, the loads were temporarily landed at the extreme swing of the boom. The boom was then passed back of a disconnected stiffleg and proceeded with the erection after the stiffleg had been replaced.

The old roof was wrecked as soon as the tenth-floor slabs and the new side walls of the ninth floor were in place. The floor was maintained in a fairly water-tight condition. It had originally been intended to require that the new roof be placed before the old was removed.

All materials other than steelwork, including concrete and débris from the old roof and cornice, were handled in the construction elevator at the rear of the building. Floors were built on the Witherow system, with removable steel centers on which were cast a beam-and-slab floor framing into the steel floorbeams.

McClure & Spahr were the architects, and James L. Stuart was the contractor.

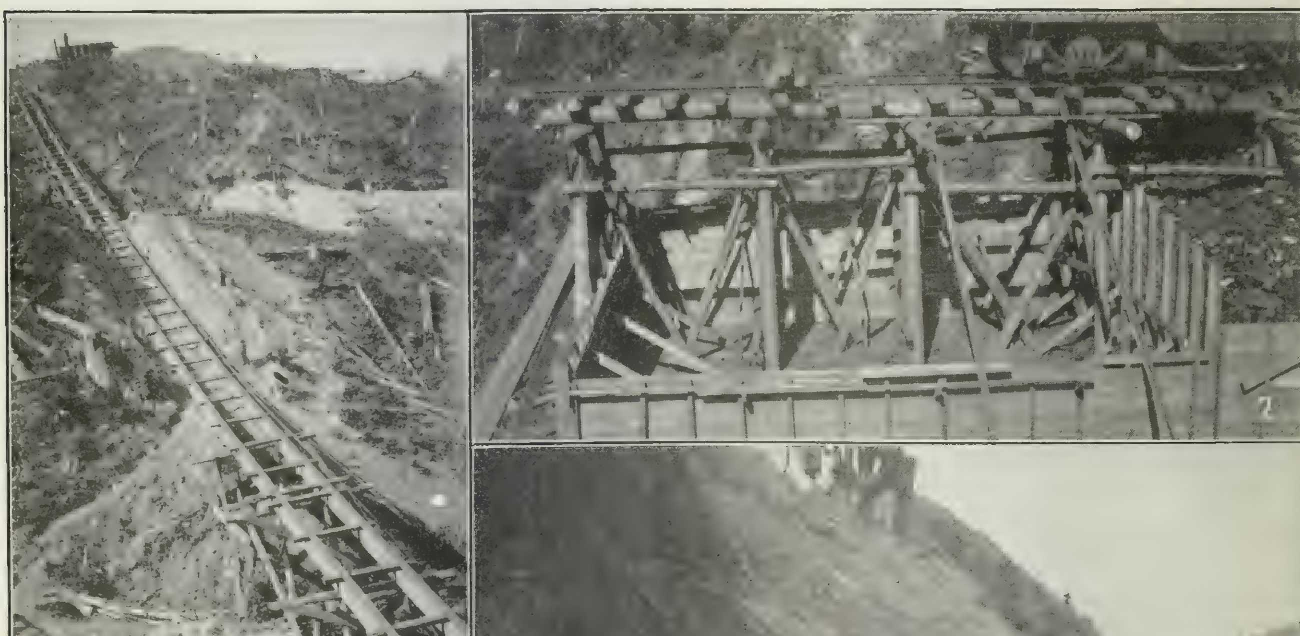
Concreting the Footings and Piers of a Viaduct 196 Ft. High

Foundations for what will be the highest track structure on the Southern Ry. are now being put in near Toccoa, Ga., on the 50-mi. relocation now about 50% complete. This structure is a double-track steel viaduct at station 7980.59 (from Charlotte, N. C.), 196 ft. high and 1,000 ft. long.

As originally designed, the viaduct was to consist of girders carried on concrete abutments, two hollow square concrete piers and six steel towers 180 ft. high. The spans from south to north (toward Charlotte) were to be as follows: 100 ft. 6 in., 113 ft. 4 in., 93 ft. 2 in., five spans 80 ft. each, 93 ft. 2 in., 113 ft. 4 in., 100 ft. 4 in., 100 ft. 6 in. After the concreting plant for such a structure had been practically installed, the design of the viaduct was changed to all 100-ft. spans between hollow towers of concrete having circular interiors and rectangular exteriors, and spaced 128 ft. c. to c. The purpose of this article is to describe the concreting plant as originally laid out to take care of the abutments, two concrete piers and the footings for the six steel towers. It will be enlarged to supply the increased amount of concrete now required.

The North Broad viaduct crosses a valley 2,000 ft. wide between precipitous hills about 110 ft. high. The present railway line rounds the hill bounding the valley on the north. Here a short spur has been extended over some material bins, shown in Fig. 2. The bin at the extreme right contains coal. The others are for sand and cement. These bins discharge into narrow-gage cars underneath.

The material trains run across the valley to the foot of the south hill, where a cement house is located. From this point an inclined cable tramway 500 ft. long ascends on a 45% grade to the concrete plant at the top of the hill. The car on the cable track is simply a frame formed of two longitudinal stringers and two crosspieces, carried on four wheels. This tramway is shown in Fig. 1. Alongside the tramway at the top are located the cement house and space for sand and broken stone stor-



FIGS. 1 TO 3. CONCRETING THE FOOTINGS FOR HIGH VIADUCT ON SOUTHERN RY., TOCCOA, GA.
Fig. 1—Incline to plant. Fig. 2—Bins at railway. Fig. 3—Quarry

FIG. 1. SHOWING STEAM-SHOVEL MACHINERY ANCHORED ON A HULL

age. The stone is brought in on a short trestle carrying a narrow-gage track leading from the quarry (Fig. 3), which is about 1000 ft. south of the mixer and on the right-of-way of the new railway line. The stone is dumped off the trestle onto a storage pile and lifted by a bucket conveyor to the crusher, which delivers within reach of the mixer. In front of the sand pile and a few feet below it is the concrete mixer, delivering to the various footing forms by a cableway about 2000 ft. long, the towers of which are on opposite banks of the valley.

The North Broad viaduct is on the contract section worked by C. W. Lane & Co., of Atlanta, and is being erected by that company.

Dredging with Steam-Shovel Equipment Mounted on a Hull

On canal clean-up work at Trenton, N. J., the Pennsylvania R.R. is using a very unusual sort of dredge, consisting of the machinery of a small revolving steam shovel mounted on a wooden hull. The boom and dipper handle are especially long, making it possible to dig to a depth of 9 ft. below water and dump material 28 ft. from the centerline of the boat and 6 ft. above water. The hull is 40x18½ ft. in plan by 4½ ft. deep. The outfit is efficient for digging small ditches or for dredging shallow streams. It is cheaper to build than a regular dredge for the same service and is much cheaper to operate. The shovel used is of the Osgood 18 type.

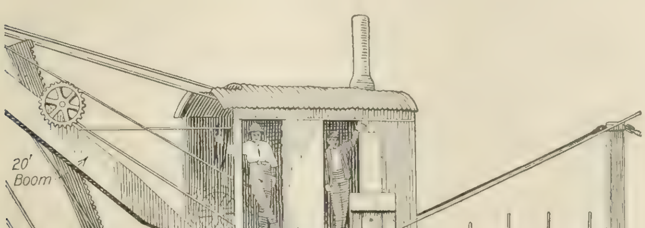


FIG. 2. HOW THE SPUDS ON FLOATING PILEDRIVER ARE OPERATED

The truck frame of the shovel—axle and axle bearings removed—is bolted to the hull. The heavy end-plate is bolted both to the shovel frame and (by means of an extension plate) to the hull.

The special parts required to build this outfit are the spuds, spud machinery, backing drum at the foot of the boom, and the hull upon which the machinery is mounted. The general arrangement is shown in Fig. 1, while Fig. 2 shows exactly how the spuds are operated.

To move the dredge forward: First, the dipper is placed far ahead; next, the hull is floated by raising the spuds; then, by starting the boom engines, the hull is caused to move toward the dipper. The spuds are then dropped, thus anchoring the hull, when the dredge is again ready to excavate.

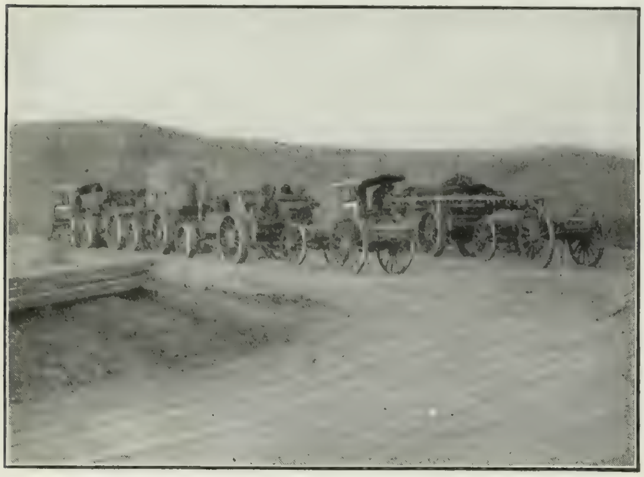
FINE AGGREGATE

Eccentric Loading of Columns—The question of when and how eccentric loading is to be taken account of in proportioning the columns of buildings is raised by H. G. W. Inasmuch as sound engineering and most building ordinances require due account to be taken of eccentricity, it is important to know in what case the load applied by beam connections is an eccentric load. But H. G. W. says: "I understand from people connected with bridge-shop offices that it is customary to disregard eccentricity except where the beams are bracketed far out, as at crane girders. Wall girders of ordinary buildings ought to be eccentric in the same way. What is the practice in this matter among responsible engineers?"

Northwestern Arc of Primary Triangulation Completed—The United States Coast and Geodetic Survey has completed the observing of an arc of primary triangulation which extends 630 mi. from northern Utah northwestward to the Columbia River in northeastern Oregon, thence westward down the Columbia River to Portland, Ore. About 100 stations have had latitudes and longitudes accurately determined; and as these points have been substantially monumented, they will be available for starting points of Federal, state, boundary and other surveys and engineering works. As soon as the office computations can be made at the Washington headquarters of the Coast and Geodetic Survey, the data for this survey will be published. The party, under C. V. Hodgson making this survey used for the first time automobile trucks on primary triangulation, and the trucks proved so successful

that all other surveying parties engaged on similar work will use this means of communication. The trucks carried the party and outfit to the base of the peaks on which observations were made. The camp equipage and instruments were carried from the truck to the top of the peak by horses or by members of the party. Accurate elevations of numerous mountain peaks were determined by this survey. Most of the observations were made at night by use of acetylene lamps. The longest distance observed was 134 mi. between a peak in northern Utah and a second peak in southern Idaho. The lamps were cared for by trained light keepers.—Bulletin of United States Coast and Geodetic Survey.

Cement That Cost as Much as Flour Hauling cement barrels by caterpillar tractor across the desert is shown in the accompanying view. The hauling was done for the Gem Lake and Agnew dams for the Pacific Power Corporation. These dams, as described in "Engineering News," Dec. 21, 1916, p.



CATERPILLAR TRACTOR HAULS CEMENT ACROSS DESERT

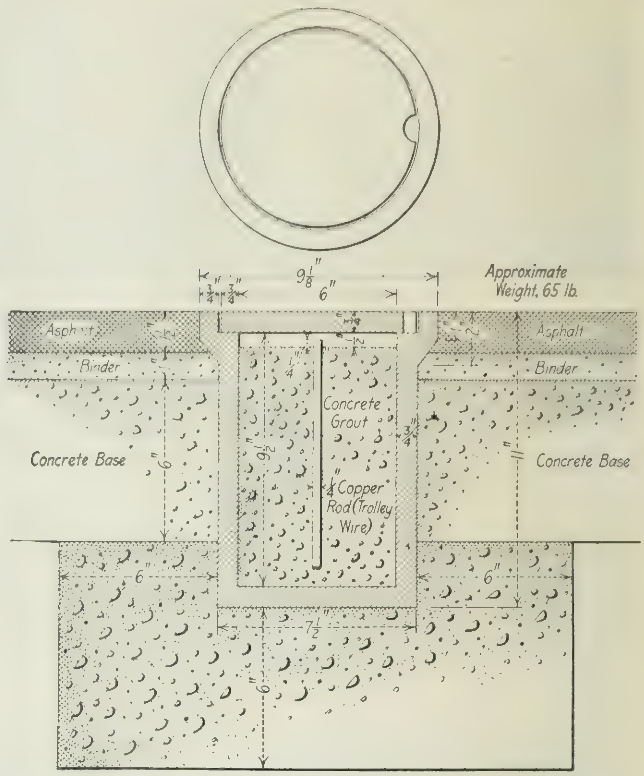
1157, are located in the upper levels of the Sierra Nevada Mountains and are 60 mi. from the nearest railway station. The materials had to be brought in by caterpillar tractor, tramway, lake barges and tramway, which brought the cost of cement at the site up to $7.50 per bbl.

A Novel Progress Chart for Bridge-Pier Sinking is used by P. B. Spencer, Division Engineer of Construction for the New York, New Haven & Hartford R.R., in charge of the construction of the new Thames River bridge of that railway. Holbrook, Cabot & Rollins are the contractors. The chart is really a mechanical device similar to a slide rule with six slides, one for each of the six sinking units of the bridge substructure. The slides are of stiff cardboard, retained in slide-chases formed of cardboard strips glued over filler or spacer strips to a back or body. The whole device, hung on the wall, gives a comprehensive picture of the condition of

PROGRESS CHART TO KEEP TRACK OF BRIDGE-PIER SINKING

progress. There are height scales on the retainer strips, and on each slide is drawn an outline of the pier box structure, which is shaded with colored crayons to describe the progress of timbering and of concreting. The sketch suggests the general appearance and arrangement of the chart.

Street-Intersection Monuments—In the recent extensive asphalt-paving work at Vincennes, Ind., the resetting of the monuments at street intersections was given careful attention. The former monuments were of limestone, 8x8x30 in., centered by a crossmark on the top. The new type is a



NEW MONUMENT FOR STREET INTERSECTIONS AT VINCENNES, IND.

cast-iron cylindrical box 7½ in. in outside diameter and 11 in. deep over all, with a flanged top for the cover. This box is set in approximate position when the foundation is laid. As soon as this is completed, the casting is centered with a transit, and the center lines of the streets are cut on the top. A ¼-in. copper rod is then set in concrete grout within the box and adjusted to the exact center. It is found best to center the monuments before the top coat is laid, on account of liability of error in setting the castings. This monument was designed by H. T. Watts, City Engineer.

Concrete Made with Silicate of Soda is suitable for pavement foundations, according to a paper by George C. Warren, President of Warren Brothers Co., Boston, Mass., read before the engineering section of the American Association for the Advancement of Science, Dec. 28. He said: "During the past year the laboratory of the Warren Brothers Co. has done a great deal of work investigating the use of silicate of soda as the cementing material for concrete foundations and finds that in connection with a substantial waterproof bituminous wearing surface it is quite practicable to make a high-grade concrete foundation in this way. The question is one of relative prices of portland cement and silicate of soda and consequent first cost of construction. We have also successfully laid approximately 10,000 sq.yd. of wearing surface over concrete made of silicate of soda and crushed stone, which had failed to successfully withstand vehicular traffic as a road surface in Cos Cob, Conn., and Sudbury, Ont. The silicate of soda concrete has greater resiliency and less rigidity than portland-cement concrete and apparently materially lessens, if it does not entirely overcome, the cracking troubles of portland-cement concrete foundations." The solubility of silicate of soda in water is not referred to, but this is certainly a factor in the permanence of any pavement constructed with it. Silicate of soda concrete has been used to some extent in road pavements under the trade name "Rocmac," which is a mixture containing also sugar, powdered limestone and other ingredients.

Editorials

Horizontal Fire Exits To Safeguard New York Hospital Patients

Every engineer and every official responsible for the design or maintenance of buildings housing large numbers of people ought thoroughly to understand the great advantage that horizontal exits have over the ordinary vertical fire escapes to safeguard life in case of fire. The value of horizontal escapes and the defects of vertical fire escapes were first clearly recognized and stated by H. F. J. Porter, Consulting Engineer, in a paper read in 1913 at the Baltimore meeting of the American Society of Mechanical Engineers.[1] *Engineering News* was the first among technical journals to recognize and call attention to the great importance of the principles laid down in Mr. Porter's paper.

As some of our readers will recall, Mr. Porter demonstrated by figures based on actual experiments the utter inadequacy of the ordinary outside metal fire escapes or even of ordinary stairways to furnish sufficiently rapid egress for the crowds contained in many present-day buildings, in case of the rapid spread of fire. The horizontal exits that Mr. Porter advocated are provided by carrying a fireproof partition wall from the cellar to the roof with doorways at each floor, closed by fireproof doors. If a fire occurs on any floor, those threatened by it can quickly pass through the doorway to the other side of the firewall, and the door is closed behind them.

Not only is this simple method of safeguarding life of great value in connection with factories, loft buildings, schools, department stores and other buildings used by great numbers of people, but it offers for the first time a means of safeguarding the lives of the helpless inmates of hospitals, almshouses and other institutions. It would be impossible in most cases to carry helpless, bed-ridden patients in any considerable number down long flights of stairs in time to save them from the rapid spread of flames; but with the horizontal exits the beds with the patients in them can be rapidly wheeled through the open doorway to safety on the other side.

Elsewhere in this issue is described the work carried out by direction of the late M. J. Drummond, when Commissioner of Charities of New York City, under which the city hospitals, almshouses and other buildings of the Department of Charities, most of them not fireproof, have been so remodeled by the provision of firewalls and horizontal exits that their 17,000 inmates are safeguarded from the dangers of fire.

Of course, to carry out the horizontal-exit idea in the ideal manner, the firewalls should be located and constructed when the building is erected. In this case the cost would be trifling compared with the ordinary plan of providing vertical fire escapes. In the buildings of the New York Charities Department, however, it was found possible in nearly all cases to utilize existing partitions so that the entire cost of establishing horizontal exits in the 206 buildings of the Charities Department was only $117,000.

The good example set by New York City ought to be followed by every city in the country. Here is an opportunity for engineers to render a real public service by urging upon public authorities the duty of giving protection to the helpless inmates of public institutions against a horrible death by fire. This plan of protection against the dangers of fire, if followed there, moreover, will gain a wide publicity that should lead to its adoption for other types of buildings and eventually put an end to the disgraceful and needless holocausts that have occurred so frequently in the United States during the past dozen years.

[1] "Engineering News," July 31, 1913, pp. 224, 228.

America's Part in Rebuilding Europe

Many of those who endeavor to forecast the condition of American industry and finance in the period following the conclusion of peace appear to have fixed their attention solely on the stoppage of the demand for war supplies. But when it is no longer necessary for Europe to draw on America to supply her troops in the field, she will still find it necessary to buy from America vast quantities of goods to repair the devastation wrought by the war and to put her farms and factories on a working basis.

A commission of twelve prominent engineers and businessmen was sent to France last fall by the American Manufacturing Export Association to ascertain the extent to which American enterprise and industry would be called upon to help restore the devastated portions of France after the war. One of the members of this commission, Noble F. Hoggson, describes in *System* for January some of the results of the commission's investigation. He reports that the value of the property destroyed in northern France alone is in excess of 2½ billion dollars. No less than 753 cities and towns have been partly or wholly wiped out. The total number of buildings damaged or destroyed is given as over 46,000.

On the farms of France, it is estimated that one-half the horses and oxen heretofore used for draft purposes have been killed in consequence of the war. The scarcity of labor, also, as a result of the many men killed and incapacitated by the war, will make necessary the use of farm machinery on a scale hitherto unknown. The French manufactories of farm implements have been converted into munition plants, and to restore her agriculture, France must draw heavily on other countries for agricultural machinery and tools. Many of the French industrial plants outside the war zone will need new tools of modern type, as their equipment prior to the war was antiquated and cannot survive the new conditions of increased labor cost. The French people also look forward to a great revival of travel when the war is over and estimate that nearly $100,000,000 must be expended

in building additional hotels to care for tourists. Material and equipment for these must largely be imported.

These are the conditions in France alone. In other countries also—in Russia, in Italy, in Belgium and even in the neutral countries—the demand for foreign materials and goods, when once the barriers on international trade are removed, are bound to be enormous.

The limit to this demand, obviously, will be the ability to raise the money to pay for these goods. With peace once reëstablished, however, each nation will without doubt extend almost unlimited credit in order to meet the urgent necessities of its people. There can be little doubt also that, with peace once reëstablished, vast amounts of capital in the United States and in other countries, which is withheld from foreign investment while the outcome of the war is uncertain, will be unlocked and available for restoration purposes.

The Narrow-Gage Delusion

Was there ever a scientific fallacy that caused the waste of so many millions of dollars as the idea that the cost of constructing a railway varies directly with the gage of its track? It was this fallacious idea that formed the foundation of the narrow-gage railway craze that started a half-century or so ago and misled many engineers as well as the general public. Probably many of those who originally promoted narrow-gage railway construction, while not so ignorant as to believe in this fallacy themselves, shrewdly perceived that the public could be made to accept this idea and consequently could be induced to invest its money in building narrow-gage roads in the belief that the roads would be built so cheaply that they would be profitable.

In the United States the fallacy that the narrow-gage railway is cheap to build and to operate has been so thoroughly demonstrated that narrow-gage railway construction has practically ceased. In foreign countries, however, the narrow-gage fallacy still persists. The Panama government completed last year a narrow-gage railway 57 mi. in length, extending from the coast inland in the province of Chiriqui. The road has heavy grades, up to 5%, but the curvature is not excessive. On several divisions the maximum curve is only 5° to 6°, and on the division of the most crooked alignment the maximum curvature is only 12°. In a paper describing the construction of this road by A. F. Zinn, its Chief Engineer, read before the Western Society of Engineers on Nov. 6, Mr. Zinn said:

> The saving in cost in construction and equipment of a narrow-gage railroad compared with a standard gage is not as great as many engineers believe. The principal saving is in the cost of ties, ballast, excavation and bridges, the total saving being approximately only 6%.

This difference in first cost of construction will be fully offset by the lower cost of maintenance of a standard-gage track on any line free from sharp curvature and carrying any considerable traffic. The narrow-gage track, especially where heavy equipment is run over it, will not stand the neglect in maintenance that a standard-gage track will, for low spots in the rail are sure to cause serious lurching and rapidly grow worse. Further than this, where money must be economized in construction and equipment, it is usually possible to buy second-hand standard-gage rolling stock of light weight in fair condition at lower cost than for special narrow-gage equipment.

About the only location where the construction of a narrow-gage line can be justified on grounds of economy is in very rough, mountainous country, where extremely sharp curvature is necessary to reduce construction cost. There are probably places of this sort where the construction of a narrow-gage road can be successfully defended. Such roads, however, form a very small percentage of the mileage of narrow-gage railways.

If the engineer engaged in railway construction in the newer countries of the world can make his clients understand that the first cost of railway construction is dependent on the weight of the rolling stock used and not on the gage of the track, he may by this one accomplishment alone save many times his salary.

Piling Up Public Debts

The City of Toronto, Ont., in 1905 had a "permanent" debt of $24,000,000. At the close of 1915 this debt had increased to over $86,000,000. Public works now under way for which bonds will have to be issued will raise this amount to $109,000,000, according to a report recently presented to the Toronto authorities by T. Bradshaw, the Commissioner in charge of the city's finances.

In addition to this amount, other public works are in contemplation and not yet financed which will cost over $21,000,000. The city has heavy obligations to meet in connection with the charges on the municipal hydro-electric system and insurance on the lives of its citizen soldiers. The interest and sinking-fund charges on the city's debt amounted in 1915 to $5,795,000, and Commissioner Bradshaw says there is a certainty of a further heavy increase during the next year or two, when the works now being paid for by temporary financing have bonds issued on their account. The population of Toronto is about 450,000 and is not increasing at the present time, while the tax assessment is practically stationary. With the population of 450,000, it will require an annual payment of $13.50 per capita to meet annual debt charges of $6,000,000. Inasmuch as a high rate of interest must be paid on all bonds issued at the present time, it is probable that the annual debt charges will considerably exceed even this large amount. In view of the conditions above set forth, Mr. Bradshaw says:

> We have reached a condition in our affairs which demands that we resolutely refuse to embark upon any new enterprise. The City of Toronto will have to decide within the next few years what it shall do in connection with the taking over of several utility enterprises. It would be no less than a catastrophe if we found ourselves financially unable to handle them in a manner which would be in the best interests of the city and its taxpayers. Again, it is a well-known fact that at present labor, material and capital are very dear. The cost of new work is almost double what it would be under normal conditions. Are we justified, therefore, in prosecuting new work and services at such a period? Another question which should receive serious consideration is, What preparation are we making for the employment of our citizen soldiers when they return home? It is essential that we conserve our energies and our resources now so that we may be prepared for that which may be expected of us in the future.

The financial condition of Toronto is unfortunately typical of that of a considerable number of other cities in the United States and Canada. It may be granted indeed that these burdens of municipal debt seem modest compared with those under which the belligerent nations of Europe must hereafter struggle; but they are surely serious enough to emphasize the wisdom of the warning which Commissioner Bradshaw sounds, and which gives

sound advice for many other cities to heed even though their load of debt is not so pressing.

In searching for a cause for the unfortunate financial condition in which so many cities now find themselves, there is a world of meaning in one word used by Commissioner Bradshaw in his report, where he characterizes certain obligations of the city as a "permanent" debt. What good reason can be given why a city should have such a thing as a "permanent" debt any more than an individual or a business firm should? Doubtless Commissioner Bradshaw used the term to signify the debt represented by long-time bonds compared with floating indebtedness; but unfortunately most American cities have a very large amount of permanent debt outstanding, which is "permanent" in the sense that there are no tangible assets now existing to offset the debt. The money was spent for pavements which have been worn out and torn up; for buildings which have become obsolete and have been torn down; or it was merely borrowed to pay deficits in the current running expenses of the city.

There is no remedy for such financial crimes of the past, but it is at least the course of wisdom to see that similar crimes are not repeated in the future. The foundation principle of sound finance is that the city should not borrow money to pay for any piece of work without making provision that the loan will be all repaid, interest and principal, during the life of the work.

A reason why it is especially important to emphasize this warning at the present time, is that cities everywhere are likely to embark during the next decade on the ownership and operation of public utilities which have heretofore been in the hands of private companies. One of the greatest dangers to municipal finance is that in operating such utilities there is always a strong tendency to reduce the rates charged below what is necessary to maintain the city in sound financial condition.

With a municipally owned water-works, for example, there is always a strong tendency to reduce rates to water users on the ground that such a measure is popular with the voters; or to give free water for a term of years to new manufacturing industries on the ground that this will help to boom the city; or to burden the water-works with the supply of water to public buildings and for the use of the fire department, even though there may be large bond issues outstanding and more water revenue is needed to pay them off.

The cities which have attempted to own and operate municipal docks have found that constant pressure is brought to bear to reduce the rentals or other charges below the point that makes the investment profitable to the city, on the ground that it is necessary to retain business in the city and prevent its being driven elsewhere. Most of the municipal electric-lighting plants are charging a far lower rate than is charged by the corporations.

The steady increase in municipal debt should compel an attention to these matters in the future that has not been given in the past. Cities everywhere are up against the problem of raising additional revenue to meet their necessary expenses and to carry on the various additional activities which public opinion all the time demands. The general property tax has by common consent about reached its limit as a means of raising revenue. Cities will be compelled, therefore, to adopt the policy of carrying on the public utilities in their control on a basis that will yield a profit to the city treasury instead of a deficit.

Waste-Material Disposal at New York

Few people realize what a vast amount of waste material is disposed of annually at New York City by being placed on board scows and carried out to deep water in the ocean. The annual report of the Chief of Engineers states that in the 16 years from 1890 to June 30, 1916, a total of 460,313,000 cu.yd. of waste material has been deposited at New York City. This is roughly about twice as large a volume as the entire amount of material excavated for the Panama Canal. The amount of material handled at New York last year was 20,800,000 cu.yd.

Prior to 1888 there was no law regulating the dumping of material in New York harbor and adjacent waters. Those who disposed of street sweepings, dredgings, etc., often dumped them in the navigable channels, from which they had later to be dredged. Since 1890 the deposit of waste materials has been under supervision of the Engineer Department, which uses a fleet of five vessels in its work. This supervision has cost over \$2,000,000 in the 16 years since it was established. The necessity of the work is apparent, since this vast volume of material, if allowed to be deposited in the navigable waters of the harbor, would very rapidly cause shoaling. A simple computation shows that if the 460,000,000 cu. yd. were equally deposited to a depth of 6 ft., it would cover an area of nearly 80 square miles. The official report says:

> Experience has shown that any relaxation of a strict patrol is sure to result in injuring the channel by illegal dumping. Enormous amounts of material are daily carried to sea by people who have little hesitation of dumping anywhere, if they are not watched. The distance to the point of disposition varies from 25 to 40 miles, and the character of the material is a powerful incentive to get rid of it as quickly and with as little expense as possible.

It is to be regretted that a larger amount of this material is not used for filling in shallow waters and tidal swamps in and near the metropolitan district, where it would serve a useful purpose instead of being wholly wasted by dumping at sea. About a quarter of the material deposited since 1890 has been used for shore filling, but the proportion ought to be largely increased. This is especially true of street sweepings, ashes and rubbish, which contain a good deal of floating material that often causes more or less nuisance on adjacent beaches when dumped at sea.

Doubtless a much larger amount of material would be used for filling in land if more economical means were available of unloading material from the scows and transporting it over the area to be filled. If this part of the work could be done at low cost, the opportunities for land reclamation over the enormous areas of shallow water and swamp land about New York City would make it profitable to use the material in that way.

The critical portion of the Miami flood-protection engineering, the design of the great earth dams and the means for passing a limited flow will be dealt with in our next issue, Jan. 25. This part of the design problem had to face an extreme degree of fear of dams among the inhabitants of the valley and most formidable difficulties of a technical nature. The solution worked out must be ranked as a classic in the field of water storage and control.

Letters to the Editor

Absurdly Low Salaries Paid Detroit's Engineering Employees

Sir—Your editorial "Do Engineers Need to Eat?" touches a point which is secondary to the main purpose of the report of the Detroit Bureau of Governmental Research on Detroit's sewer construction namely, to raise the standard of sewer construction in Detroit. However, the old question of compensation is always with us and is always interesting, and I hope that your editorial will reopen a discussion which will break away from beaten paths and result in tangible benefit to the engineering profession.

In place of the caption "Do Engineers Need to Eat?" one more to the point would be "Are Rodmen Engineers?" Not "Should Rodmen Be Engineers?" but "Are Rodmen Engineers?" As a general proposition rodmen are not engineers. In our opinion rodmen should be engineers—embryo engineers. Preferably, they should be inexperienced technical graduates. A graduate with one or more years' experience prior to graduation will be an instrumentman or better, as the amount and kind of his experience warrants. The position of rodman should be the first step in the line of experience and promotion.

But the inexperienced technical graduate, at first probably will be no better than an able-bodied laborer. His investment in technical education cuts no figure at this point in the game, and for services rendered he certainly is worth no more than the laborer. He is serving his apprenticeship; and if he is satisfied to remain indefinitely as a rodman, he ceases to be an embryo engineer, becomes merely a rodman, and the laborer who rates his task as a good job is just as good, perhaps better. Your comparison, therefore, of the rodman's monthly compensation with day-labor wages is to the point. If the figures used prove anything, they prove that $85 per month as compensation for rodmen is about right, perhaps a little high, because usually it is a steady job.

Parenthetically, we would note that the minimum wage at the Ford automobile plant is $5 per day only after six months' probation. Prior to Oct. 10, 1916, two rates for unskilled labor were in effect—34c. and 38c. per hr. Since that date, due to the increased cost of living, the hourly rate has been raised to 43c., or for an 8-hr. day $3.44 for employees over 18 years of age. Children are not employed at the plant.

The report quoted also states: "The salary of the sewer engineer—$2000 per yr.—is altogether too small for the responsibilities involved." Think of it! A rodman at $1200, and the engineer in charge of contract sewer construction at $2000 per year!

For the sake of a concrete example, let us give more Detroit figures. A tabulation showing the positions in the Department of Public Works receiving above $2000 per yr. is:

Commissioner	$7,500
Secretary	3,200
City engineer	4,000
Principal assistant city engineer	2,700
Asphalt expert	3,700
Superintendent of paving	2,800
Superintendent of paving	2,600
Superintendent of street cleaning	2,800
Superintendent of sewer maintenance	2,800

These are the salaries of the men administering the affairs of a department with a $6,000,000 yearly budget for a rapidly growing city, with a present population of 750,000. Is not the profession of engineering cheapened by such salaries? A salary of $7500 for the head of this department may appear big to engineers, but not to businessmen, who do big things in a big way and at the same time know the value in dollars in services rendered. A salary of $4000 for the city engineer may satisfy some engineers, though we doubt this. But as compensation for the head of the technical bureau of a booming city like Detroit, confronted with immense problems in transportation, sewerage, paving and all aspects of city planning, this amount is not only ridiculous, but pitiful.

Centering fire on the compensation of rodmen is misdirected effort. First, let us employ embryo engineers as rodmen. Then broken-down barbers, bookkeepers, retired bar tenders, would-be politicians and relatives of politicians, as rodmen and inspectors, will disappear from our municipal-engineering payrolls. Gradually, the engineering personnel of our municipal department will change complexion, and the question of compensation will be adjusted.

Compensation depends primarily upon two factors—the requirements of the position and the caliber of the man occupying the position. Theoretically, the first factor only should count, because theoretically the incumbent should meet at least the minimum requirements of the position. But in practice the caliber of the man occupying the position is considered. For this reason, while many of our city officials and employees may be overpaid, the positions they occupy, but do not always fill, are often grossly underpaid.

Observation indicates that businessmen of vision, who of late years are more frequently found on our public-improvement commissions, are the best friends of the engineer in so far as compensation is concerned. Such men value the services of the engineer, while at the same time the engineer places a low figure on his own services. Let us value our services as professional men, but first, let us look to the personnel of the engineering profession, starting with the rodmen.

Technical journals as mediums of publicity can help in this matter, but success depends on the engineers themselves and, in municipal work, primarily on city engineers and heads of public-works departments. Bureaus of municipal research are ready to help; in fact, are nelping, because in their quest for economy and efficiency they recognize that the secret of efficiency and true economy is to secure the best man for the job and pay him well for it. H. S. MORSE.

Detroit, Mich., Dec. 29, 1916.

[All of the fire of the editorial under discussion was not centered on the salaries of rodmen; indeed, that was merely incidental. Among the more important statements in the report was that a salary of $1400 was too much for a leveler and that $1500 for a chief of party, while justifiable in this case, was a little extravagant. That the salary of the sewer engineer is too low is no excuse for making all other salaries low in proportion. It is a pity that Mr. Morse did not express the same sentiments in the report that he has in the letter above.—Editor.]

Ornament and Art in Bridges

Sir—If it is the intention to spend $60,000 on bridge decoration, Pittsburgh may with advantage look over what Paris has done along this line. To nail a few bronze plaques and rosettes on latticed bridge members and say "the result expected is artistic value and educational effect" ("Engineering News," Dec. 28, 1916, p. 1243) is to ignore Ruskin's comments on appliqué work. I am aware that quoting Ruskin to an architect is like shaking a red rag at a bull, but to some of us who react feebly to the stimulus of architecture in its various and at times wonderful manifestations he is informing.

The architects tell us that a bridge truss is not a thing of beauty and lament the fact in a tone that implies guilt on our part rather than structural limitations; the truss does, however, possess character—something which I am led to believe is essential, even in a structure whose keynote is beauty. It is a bit annoying to be convicted of groveling tastes by a man who copies a Greek temple, overtops it by half a dozen stacks, calls it a power house and insists that we admire the result.

EDWIN H. WARNER.

Los Angeles, Calif., Jan. 6, 1917.

Underground Water Unlikely To Give Trouble in the Cascade Tunnel

Sir—I was somewhat surprised to read Frank B. Walker's statement in "Engineering News" of Dec. 21 with reference to the proposed 30-mile tunnel under the Cascade Range. To the layman, one million gallons per day may look like a pretty big drink to absorb, but to the engineer it reads only 1.5 sec.-ft. There are many long tunnels, successfully completed and in operation from two to fifteen years, in

which the discharge at one portal amounted to 3 to 44 sec.-ft.—that is, from 2 to 30 times as much as that recorded by Mr. Walker. Underground water is always annoying when driving and especially lining a tunnel, but it is far from being "a serious engineering matter and possibly an actual menace to traffic."

The fact that the proposed tunnel under the Cascade Range passes directly under lakes does not necessarily mean trouble ahead; on the contrary, the very existence of the lakes indicates, to a certain extent, that the underlying rock is more or less impervious. A large inrush of water is more to be feared in limestone or a like formation than in igneous rocks. In driving tunnels at great depth, a wet tunnel is preferable to a dry one, as the rock temperature is always lowered by the presence of water.

There is another feature that should be given due consideration: The proposed 12-mile tunnel from Scenic Hot Springs to Merritt would be located some 1000 ft. higher than the grade of the proposed 30-mile tunnel.

The following are some of the rates of underground-water discharge as recorded in several tunnels:

Name of Tunnel	Materials Penetrated	Length Considered, Ft.	Maximum Discharge, Sec.-Ft.
Granges, north portal	Limestone	13,930	8.5
Granges, south portal	Gypsum, anhydrite	14,163	22.0
Hauenstein	Limestone, shale	19,225	3.3
Weissenstein	Limestone	12,150	15.0
St. Gothard	Granite, mica schist	25,882	8.1
Simplon, north portal	Schist, gneiss	40,790	7.1
Simplon, south portal	Limestone, gneiss	22,900	44.0

EUGENE LAUCHLI.

2 Wall St., New York City, Dec. 27, 1916.

Sir—Frank B. Walker's letter commenting on General Chittenden's article on a proposed 30-mile tunnel under the Cascade Range says, among other things, "Should the 30-mile tunnel ever be constructed, one of the greatest troubles will be the excessive water." As I see the facts, they altogether contravene Mr. Walker's prediction. In the first place, the present tunnel is relatively very near the surface of the ridge which it penetrates, averaging a depth of perhaps 600 ft. with a maximum of about 1,200 ft. This is a superficial depth, and consequently it might be expected that the effects of weathering and of other subaërial influences would have greatly contributed to the creation and enlargement of percolation channels and other avenues for the movement of waters that the tunnel might intercept. In the second place, the present tunnel for its whole length, or nearly so, has a downgrade to the west, and yielded at the west portal, as Mr. Walker says, one million gallons per day. This yield is equivalent to 1.54 sec.-ft. for the 2.6 mi., or 0.6 sec.-ft. per mi. of tunnel, or 1.8 gal. per min. for each 15 ft. of tunnel. From a tunneling standpoint such an amount is almost negligible. If this may be taken as a criterion, then it augurs well for the lower tunnel. The porosity of the granites so near the surface always yields more water than the tightly sealed, impermeable conditions usually prevailing at great depth, such as will be occupied by most of the projected tunnel.

Dubrée, Delesse and other authorities have shown that the interstitial water content, sometimes called quarry damp, of granite is 0.37% by weight. If the daily rate of progress in driving the proposed double-track tunnel be 15 ft., then a simple computation shows that the yield of interstitial water, if it could be resolved into a flowing stream, would be 117 cu.ft. for one day's driving and would be greater or less according to progress.

The water yield in the present tunnel, according to Mr. Walker, was one million gallons per day for 2.6 mi., which is equivalent to a daily yield of 147 cu.ft. of percolation water for every 15 ft. of tunnel. In this instance we thus have as a suggestive index of yield a coefficient of $\frac{147}{117} = 1.26$ times interstitial-water content.

According to the above, we may calculate that the flow at the east portal will be 3,390,000 gal. per day, and at the west portal 6,780,000 gal. per day, the respective equivalents being 5.25 sec.-ft. and 10.5 sec.-ft. These results assume that the typical homogeneous granite will prevail throughout the length of the proposed tunnel. No doubt some diamond-drill explorations will be undertaken prior to the final adoption of the plan, and they will probably fairly establish the nature of the lithology.

But it may be objected that inasmuch as the present tunnel does not pass under or near any streams or lakes and that inasmuch as the one proposed is to pass under a number of streams and possibly some lakes that the yield of the latter cannot in any wise be predicated upon the yield of the former.

Suppose that the yield per unit of length were 10 times greater in the proposed tunnel than in the present tunnel; then we would have 60 sec.-ft. discharging at the east portal and 120 sec.-ft. at the west portal. On the eastbound gradient of 0.1% as proposed by General Chittenden, this would give a velocity of about 4.5 ft. per sec. in a lined drain channel having a hydraulic radius of, say, about 1.25, which means a wet section of 13.5 sq.ft., the equivalent of about 3-ft. depth of water in the flattened invert of a side tunnel 6 ft. wide. On the westbound gradient of 0.2%, with hydraulic radius of 1.46, the velocity would be about 7 ft. per sec., thus giving nearly the same depth of water in the invert.

It thus becomes clear that even on the assumption of a flow 10 times greater than the yield per unit in the present tunnel this amount of water would still impose neither a handicap upon the progress of the work nor extra cost in construction.

The St. Gothard tunnel, 9.5 mi. long, passes under the Kestelhorn, the peak of which is about 6000 ft. above the tunnel, also under the St. Anne glacier, and under the River Reuss six times, without encountering a water-bearing fault or any fault.

It is a well-known geologic fact that homogeneous and insoluble rocks like granite, although characterized by divisional planes caused by the dynamics of shear and fracture, seldom have open fissures at depth. The system of joints which have contributed so largely to the type of scenery and physiography of this wonderful region are not faults. The permeable depth to which they originally descended has long since been reached by the subaërial agencies of erosion, so that the waters of the several streams under which the tunnel is to run are hermetically impounded hundreds of feet above. Gashes near the surface may exist, but profound fault planes filled with breccia or attrition matter for the carriage of water are now undoubtedly nonexistent. In places through the Cascade fields there are north-south dikes, but these are tightly sealed and offer no possible percolation channels. Almost the entire route of the proposed tunnel is traversed by a massive granite of remarkable homogeneity. Such a formation is not a water-bearing one.

The most notable feature of the drainage system of the region is the remarkably flat gradients (almost railroad gradients) of all the larger streams and the unusual distances which those low gradients extend up toward the head of the streams. The result is that the extreme upper end of the gradients running up to the main divide and the portion thereof which the proposed tunnel undercuts are very steep and precipitous. Clearly, this is a condition that will give an immediate 100% runoff of surface waters. This, then, is the physiography that has resulted in defining both sides of the range into colossal escarpments.

There are many cirques, or bowl-like recesses, of glacial origin, surrounded by precipitous walls often several hundred feet high, but in every instance one side of their rims has been eroded completely away, and the break always heads into the stream-cut channel as a part of the drainage system. Consequently, notwithstanding the great amount of precipitation, the presence of many surface streams over the tunnel and the rugged complexity of knife-edged ridges, tapering monoliths and peaks, terrenes, cirques, miniature valleys and sweeping slopes, the whole drainage will shed water like a shingled roof.

These bold structural and unique features must translate themselves into favorable significance for the tunnel project; and if not conclusive, must certainly go far toward sustaining the contention that the tunnel will not encounter excessive amounts of water. J. C. RALSTON.

Spokane, Wash., Jan. 3, 1917.

Better Salamanders Suggested

Sir—The time of the year is here when the great majority of concrete-structure failures occur, and the salamander appears in an attempt to promote proper setting. My own experience, and I find it the experience of others, is that the hot dry air from the salamander fire dries out the concrete directly above the stove too quickly, so that often the concrete there can be picked to pieces with the fingers. I have been wondering if a small change in the salamanders would not prevent this action and so add to the safety of winter work.

I would add three or four short legs to the top of the salamander and have these support the rim of an inverted cone of the same diameter as the stove. This addition would serve two purposes: First, it would deflect the hot-air blast so that the current would not rise so directly to the ceiling. Secondly, the cone could be kept filled with water, the evaporation of which would moisten the rising air and further protect the concrete from rapid drying out.

The extra cost of the cone would be small.

Ohio State University, Dec. 18, 1916. W. NEILSON.

Four Spans of Union Pacific's Omaha Bridge Rolled to Place

Replacing the old double-track Missouri River bridge of the Union Pacific R.R. at Omaha, Neb., by a new bridge on Saturday, Dec. 23, 1916, was one of the heaviest bridge-rolling jobs ever accomplished. The four 250-ft. river spans were rolled in simultaneously, a total weight of 3580 tons. The four old spans, weighing 1950 tons, were rolled out onto trestle extensions of the piers before the new spans were moved.

The five main piers of the old bridge, resting on rock about 75 ft. below water, were used without change for the new structure.

The new spans are 246 ft. 3 in. long c. to c. of end pins, 47 ft. deep at the center, and have trusses spaced 31½ ft. apart c. to c. In place of the Whipple truss system of the old spans, they have 10-panel curved-chord Pratt trusses. Both old and new bridges are pin-connected. The total length of the bridge is 1749 ft.

The design of trusses as well as floor is normal; the comparison of weights (3580 tons against 1950 tons, for the four main spans) indicates the difference in strength. A special feature is a set of pier girders, three 27-in. plate girders under each end of each span, longitudinal of the pier, to reinforce the pier masonry.

The new spans were erected on falsework, just downstream of the old bridge. Timber-trestle pier extensions founded on piles were built downstream and upstream of the piers (the upstream extensions to receive the old bridge when rolled out); when the spans were completed they were swung on these trestles and the intermediate falsework removed. One of two channel openings had to be kept clear of falsework during the erection but this requirement did not complicate the work.

The pier girders, carrying the fixed and expansion shoes, were erected with the new spans, and served as track girders bearing on the traveling roller nest.

The old spans were jacked up 2 ft. to raise the track, after the new structure had been erected, because the new floor is deeper than the old by this amount. At the same time the roller tracks were inserted. The jacking was done on one pier at a time, the grade running out easily in a span length.

The traffic across the bridge is extraordinarily heavy, averaging 300 trains per day for a year. For this reason moving the bridge between trains was not contemplated. Arrangements were made to detour trains over another bridge.

Each span was fitted with a 9-part hauling tackle at each end. The lines were handled by hoisting engines standing on the new bridge near the piers. Travel indicators were provided to keep the engines working in unison and hold the moving spans in true alignment.

The bridge tracks were broken at 11:10 a.m., Dec. 23, and by 11:20 all was ready for the moving. The old bridge moved over without trouble, up to within 6 ft. of final position, when the breaking of a hitch caused 30 min. delay. The movement of the old spans was completed at 12 noon.

Zero temperature prevailed at the time. The cold hampered operations somewhat, but by 3:30 p.m. the

FIG. 1. UNION PACIFIC BRIDGE OVER MISSOURI RIVER BEING REPLACED BY ROLLING
Old Whipple bridge at left, new bridge at right; view looking east from Omaha end

FIG. 2. LOOKING UPSTREAM AT UNION PACIFIC BRIDGE OVER MISSOURI RIVER AT OMAHA
New bridge in foreground, on trestle supports; old bridge still on masonry

new spans were in place on the piers. The spans remained in excellent alignment throughout the moving.

The only remaining piece of work to restore track connections was jacking up the outer ends of the end spans and removing the roller nests. Freezing of jacks delayed this work. The first train crossed the new bridge about 9:40 in the evening.

The entire erection work followed schedule so closely that the actual moving date did not differ more than a week or two from that anticipated at the start of operations. The hauling power provided for the moving also proved ample, the engines being at no time overworked.

It is interesting to record that this Missouri River crossing dates back a full half-century. A ferry for transcontinental railway service was established here just after the Civil War, and a few years later the Union Pacific Ry. built a single-track bridge (begun 1869, opened 1872). This did service for 15 years. It was replaced in 1887-1889 by a double-track bridge of George S. Morison's design, which has held its place till the end of 1916—nearly 30 years.

Morison's bridge was designed for a live-load about equivalent to Cooper's E35. The 1916 bridge is designed for a Union Pacific loading not far from E65 (65,000 lb. on drivers, 5500 lb. per ft. moving load), and full impact is figured on both tracks. However, the old bridge had excess strength insofar as it was designed for two vehicle roadways in addition to the tracks—3000 lb. per ft. on each track, and 1000 lb. per ft. on each roadway, a total of 8000 for the bridge. The new bridge also has an excess over present-day requirements, the normal design loading of the Union Pacific being about E55; for this important bridge a considerable excess was thought warranted.

The new bridge was designed under the direction of E. E. Adams, Consulting Engineer, Union Pacific System, New York City; R. L. Huntley, Chief Engineer, and W. L. Brayton, Bridge Engineer, Omaha. It was built and erected by the American Bridge Co.; K. L. Strickland was in local charge of the work for the bridge company.

High Dam Part of $9,000,000 Kings River Irrigation Project

A 1,000,000-acre irrigation district project, including a high dam, a hydro-electric plant and 605 electric pumping stations, has been indorsed by Louis C. Hill, consulting engineer of the United States Reclamation Service, in a recent report to the Director of the Service. The district lies in Tulare, Kings and Fresno Counties, near Fresno, Calif. A number of canal companies now supply water from Kings River to 600,000 acres of this land, but at present there is no storage on the river.

Kings River has a drainage area of 1740 sq.mi. above the eastern margin of the San Joaquin Valley and extends back to the top of the Sierra Nevada Mountains, which range from 5000 to 14,000 ft. in elevation. Its winter discharge is flashy in character, but the stream has a more constant summer flow than the rivers farther south. The minimum summer flow is seldom less than 200 sec.-ft. and generally averages 300 sec.-ft. Winter flood flows for short periods of time have run as large as 50,000 sec.-ft.

The seasonal flow curve of Kings River follows closely the curve of irrigation demand, so that a reservoir having a relatively small storage capacity will act effectively as a regulator for irrigation purposes. The project calls for the building of the Pine Flats Reservoir with a capacity of 600,000 acre-ft. and a water depth of 300 ft. at the dam site.

An arched masonry dam of gravity section, with a 1450-ft. radius and a crest length of about 1400 ft. at a height of 305 ft. above the stream bed, is proposed. It is estimated that an annual supply of 1,700,000 acre-ft. can be obtained from the surface flow of Kings River by regulation through this reservoir.

The water plane is quite close to the surface in a large area of the lower portion of the proposed district, in some cases being within 4 ft. It is a part of the proposed plan to develop an additional supply of 300,000 acre-ft. by pumping from this underground reservoir. The plan calls for 605 electrically equipped pumping plants of 2 sec.-ft. capacity each, having an average lift of 35 ft. The electric power for these plants would be supplied from a power plant to be built in connection with the Pine Flats dam.

The total available water-supply is estimated to be 2,000,000 acre-ft. per annum, which is sufficient to irrigate approximately 1,000,000 acres of land. The irrigation season extends over a period of seven months. The duty of water for the crops raised in this vicinity varies from 2 to 2¼ ft., measured at the point of diversion. The average rainfall is 10 in.

The estimated cost of the entire project is $9,530,000, including the power plant at the dam, transmission lines and pumping plants, or $9.53 per acre benefited.

The general scheme is to buy out the various irrigation companies and organize one or perhaps a number of irrigation districts. Some of the men connected with the companies are reported as having informally approved the project and an educational campaign is under way to win the support of all concerned.

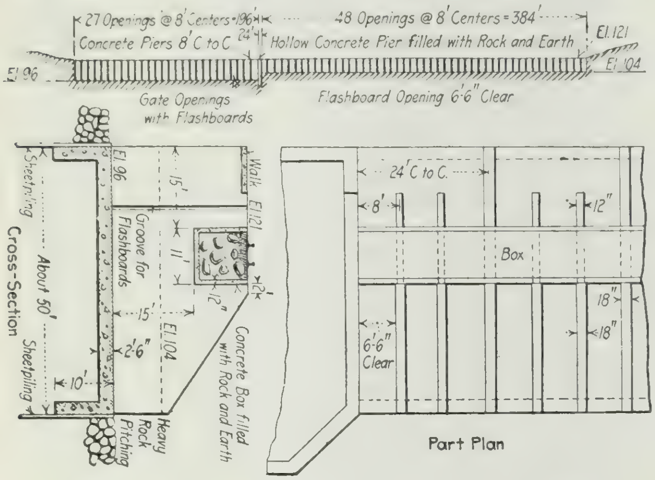
City Engineers' Offices in Office Buildings are a feature of municipal arrangements in some cities, and in several of these cases all the municipal offices are located in the building, in preference to establishing a city hall. The reason usually is one of economy, it being cheaper to rent offices than to build and maintain a municipal structure.

News of the Engineering World

New Colorado River Intake Gate for Imperial Irrigation Canal

A large new reinforced-concrete heading for the main, or Imperial, canal of the Imperial Irrigation District, California, is to be built on the California side of the Colorado River, about a mile above the present intake, called Hanlon's Heading. The new intake may be named the Rockwood Gate, after C. R. Rockwood, who was recently succeeded as chief engineer by C. K. Clarke. The new intake was designed and the specifications for it prepared by Edward R. Bowen, structural engineer in the offices of J. B. Lippincott, Los Angeles, Calif.

The intake is about 600 ft. long and consists of a reinforced-concrete floor some 50 ft. wide, carrying piers that serve the double function of supporting the flash-



DETAILS OF NEW COLORADO RIVER INTAKE
Some of the dimensions are approximate

boards and carrying an electric railway to operate the flashboards electrically from cars (see illustration). The structure will be built 50 ft. back from the present river bank, which will be shaped to the structure and protected by derrick-placed stone pitching.

The upstream end of the heading is to be built into a hill of indurated sand, and the downstream half will rest on the river silt common to the locality. Provision has been made for arc lights on top of the structure and spray lights in each bay. A new canal is being dredged from the present Hanlon Gate to the proposed new intake. The water levels in this canal may be controlled by the operation of the Hanlon Gate.

The theory of the operation of the new intake is that during high water it will skim the top 2 or 3 ft. from the surface, and because of its great length and the control of the water levels on the land side by the Hanlon Gate the entrance velocity will be small. This will result in much less trouble with drift and silt.

Rough preliminary estimates indicated a cost of about $200,000. Bids have since been received, and it is expected that the contract will soon be awarded.

New England Water-Works Association Holds Annual Meeting

There was a large attendance at the annual meeting of the New England Water-Works Association, held in Boston on Jan. 10. A report on the canvass of ballots showed the election of Caleb Mills Saville, Chief Engineer of the Water Board of Hartford, Conn., as president of the association for the ensuing year. Willard Kent, Narragansett Pier, R. I., was reëlected secretary. The total membership of the association is 1043, a net gain of 82 for the year.

In his retiring presidential address William F. Sullivan, Nashua, N. H., was very outspoken in his opinion of the correspondence campaign for the consolidation of the New England Water-Works Association and the American Water-Works Association as carried on by an unnamed journal. Mr. Sullivan advised that the agitation be ignored, and accused the journal of conducting it as a subscription-getting project. He urged that there are ample fields for both organizations and that one might as well talk of consolidating all the colleges, all the magazines in a given class or all the political parties.

A paper on "The First Slow Sand Filter in the State of Maine" was read by Henry Richards, trustee of the Gardner Water District. Mr. Gardner took up the human, social and political aspects of getting a public improvement in a conservative locality as being of more importance than the technical side of such a small installation as the one at Gardner. He attributed the fact that Gardner was the first municipality to establish a filter plant to the fact that it has the commission form of government. The filter plant has a capacity of about 1,000,000 gal. a day, and the clear-water basin holds 700,000 gal. Although the quantities of excavation, both in earth and rock, considerably exceeded the estimate, the cost was exactly the same as the engineer's estimate, or about $74,000. The population of Gardner is 8000 and is rather stationary. The water-supply was originally one of the best in Maine, but increasing population on the drainage area made filtration necessary or at least desirable.

In the course of a discussion on public-service commissions Leonard Metcalf, past president of the association, pointed out that regulation is useful in that it brings together the parties interested, making for good feeling and tending to settle issues at small cost compared with settlement by litigation.

Unique Telephone-Merger Ordinance Adopted in Austin, Texas

The voters of Austin, Tex., on Jan. 4, accepted, 6 to 1, a franchise ordinance for the merger of the local Bell and independent telephone systems and for an increase of rates for the new service. The Bell exchange (Southwestern Telegraph and Telephone Co.) had 5400 subscribers and the other exchange (United Telephone Co.)

had 800 within the city and 1500 outside. The Bell company had better long distance facilities, but the independent concern had connection with rural lines throughout the county.

The ordinance provisions are so unusual that the more important stipulations are summarized below. The full ordinance was published in an election proclamation in the Austin *American* Dec. 19, 1916.

The Southwestern company is to expend at once $300,000 in system improvements, including $75,000 for a modern exchange building with special comforts for women employees. All the independent company's aërial construction not needed is to be quickly removed. The overhead and underground equipment of both companies at the time of merger is to be shown on plans filed with the Superintendent of Public Improvements, and plans for all new construction are to be similarly filed.

Such equipment is to be under the reasonable control of the city and must not interfere with ordinary use of streets or obstruct any other utility. The company is to use alleys instead of streets wherever possible. One duct in all underground lines and part of the top crossarm of all poles are to be left and donated for the fire-alarm and police wires, but no electric power or high-voltage wires which will affect telephone service are to be placed thereon.

A definite program for removing the overhead construction is fixed. A pole line may not be rebuilt along any permanently paved street without the approval of the City Council, and where it is practical to construct a parallel line along some street or alley at reasonable expense.

Wages of local operators are to be raised not less than 10%.

The new rates are to be: $5 per month for business telephones, $1 per month for business extensions, $2.50 per month for additional one-way-service telephones, $2 per month for residence stations and 50c. per month for each residence extension. These rates are effective when the $300,000 improvments have been completed and for service through the new exchange. Rates may be raised on petition after five years provided this schedule does not yield a reasonable net profit on its capital investment in and about the city. The Council may lower rates at any time if profits are excessive. A complete inventory of the company's property is to be maintained and held open for the city's inspection and audit. In case of controversy over a rate petition a board of arbitration is to fix the value of the investment. No appeal or resort to the courts may be had by either party for modifying the award of arbitrators.

The company is required to protect the city against all damages growing out of this franchise or the construction and maintenance of the telephone system.

The life of the franchise is 25 years. At the end of 10 years, and each five-year period thereafter, the city may purchase the telephone system at a price fixed by a board of appraisers. The company pays $1250 per annum and 1½% of the gross receipts in addition to the usual lawful taxes on real property.

New York Garbage-Reduction Works Controversy May Be Over

The protracted and sometimes hot controversy over the new contract for the disposal of the garbage of New York City for the five years beginning Jan. 1, 1917, seems to have come back to roost with Governor Whitman for awhile, but under conditions so favorable to the city as to give rise to the hope that the controversy is over. Geo. C. Whipple, professor of sanitary engineering at Harvard University, and member of Hazen, Whipple & Fuller, New York City, submitted a report on Dec. 9, 1916, advising that in his opinion the proposed works would not be a detriment to health, but containing some other statements that may be noted in the following conclusions from Professor Whipple's report:

1. The transportation of garbage in scows from the boroughs of Manhattan, Bronx and Brooklyn, to Fresh Kills, Staten Island, and its disposal there by the Cobwell process of reduction, as proposed under the contract, will not, in any appreciable or material way, affect the security of life or endanger the health of the people of Staten Island.

2. The garbage-disposal works will, by reason of odors emitted at certain times, be a nuisance (within the meaning of Sect. 6 of the Public Health Law and Sect. 1530 of the Penal Law) within the low-lying part of Staten Island which may be described as the Fresh Kill Marshes, including the village of Linoleumville, the small settlement known as Fresh Kills and certain highways; but this nuisance will not extend generally over Staten Island.

3. The transportation of garbage in scows, as provided for by the contract, will, under certain conditions, be an offense to the residents of Staten Island along the Kill von Kull and to persons on passing boats and vessels on the Kill von Kull and Arthur Kill. Garbage and waste products will also be scattered so as to litter the banks of the Fresh Kills.

4. The Cobwell reduction process is the best method now known and available for the disposal of the garbage of the city of New York.

5. From a sanitary standpoint there are other sites in New York city more suitable and satisfactory for the location of a garbage-reduction plant employing the Cobwell process than the Fresh Kills site at Staten Island—namely, either Riker's Island or Barren Island.

Professor Whipple came into this case as follows: After it was decided to award the contract for a plant on the Staten Island site, Staten Islanders asked Governor Whitman to intervene. After a hearing he referred the matter (July 15) to the State Commissioner of Health, Dr. H. M. Biggs, for investigation under Sec. 6 of the Public Health Law. It was subsequently taken up by Dr. Linsly R. Williams, deputy health commissioner, Theo. Horton, chief engineer of the State Department of Health, and Wilber W. Chambers, deputy attorney-general, Professor Whipple acting as special consultant, and all three of the men named sitting with Dr. Williams at hearings on Staten Island, extending over 12 days. It was agreed that Professor Whipple should write a report after reviewing the typewritten testimony, filling 1694 pages. This he did after consultation with the other three.

Dr. Williams transmitted Professor Whipple's report and all the testimony to Commissioner Biggs, accompanied by a brief report, concluding with these findings:

1. The transportation of garbage to the site of the proposed plant and the operation of the plant at Lake Island will not affect in any material way the life or health of the inhabitants of Staten Island.

2. The transportation of garbage in scows to the proposed plant as provided for by the contract at times and under certain conditions of atmosphere and transportation will be offensive to the residents of Staten Island living along the Kill von Kull and the Arthur Kill and will thereby constitute a nuisance.

3. The operation of the proposed plant will disseminate objectionable odors at times and under certain atmospheric and operative conditions in the neighborhood of the proposed plant, including the village of Linoleumville, the settlement known as Fresh Kills and other property located in that vicinity.

All the documents mentioned were transmitted to Governor Whitman, on Dec. 27, by Commissioner Biggs, with the statement that he had carefully considered all the evidence and reports and entirely concurred in the conclusions reached. So far as has been reported, Governor Whitman has taken no action in the case.

Garbage and Refuse Disposal as practiced in various cities of the United States will be investigated by the Board of Health of Cincinnati, Ohio, with funds provided by the City Council on Jan. 9.

Sewage-Treatment Works for Dallas, Tex., were put in operation on Jan. 4, 1917. The plant consists of primary and secondary Imhoff tanks with sprinkling filters between. James H. Fuertes, consulting engineer, New York City, designed the system. Hal Moseley is city engineer.

Federal Water Power Legislation was taken up in the Senate on Jan. 11, but the opposition during the following three days was successful in preventing a vote by prolonged discussion. The prospect that legislation can be secured during the few remaining weeks of the present session appears to be diminishing.

Joint Water-Works and Sewerage Systems for six Canadian municipalities near Detroit, Mich., are proposed. The project embraces Windsor, Walkerville, Ford City, Sandwich, Ojibway and the Township of Sandwich West, and is in charge of the Essex Borders Utilities Commission, created a year ago by the Ontario provincial legislature. The chairman of the commission is Gordon McGregor, Ford City, Ont., managing director of the Ford City Motor Co. There is a board of engineers, consisting of the city engineers of the six municipalities, and having as chairman Edward Brian, city engineer of Windsor, Ont. Morris Knowles, Pittsburgh, Penn., is consulting engineer to the board of engineers.

Another Municipally Owned Garbage-Reduction Works—On Jan. 1, 1917, Rochester, N. Y., took possession of the garbage-reduction works and the collection equipment of the Genesee Reduction Co., putting itself in the class with Chicago (Ill.), Cleveland, Columbus and Akron (Ohio), Schenectady (N. Y.) and perhaps one or two other cities. The property acquired by Rochester included 16 digester tanks, presses and accessories, with a daily capacity of 175 tons, and 35 teams with steel wagons. The city exercised an option to buy at the expiration of the contract between it and the company. The price was fixed at $127,414 by Irwin S. Osborn, of Cleveland, for the city; George D. Beaston, of Philadelphia, for the company, and W. J. Springborn, New Bedford, Mass., chosen by the other two arbitrators. No plans for remodeling or extending the plant have yet been made, we are informed by E. A. Fisher, consulting engineer to the City of Rochester, but such plans may possibly be made in the future.

PERSONALS

F. H. Boyd, County Surveyor of Rogers County, Oklahoma, has been appointed County Engineer.

Charles Lawrence, Engineer of the paving department of Warren, Ohio, has been appointed City Engineer.

Joseph McGuire has been made County Engineer of Johnson County, Missouri, with office at Warrensburg.

J. T. M. Hamilton has been appointed Chief Engineer of the Meridian & Bigbee R.R., Meridian, Miss.

W. W. Lane, of Tucson, Ariz., has been appointed County Engineer of Pinal County, with offices at Florence, Ariz.

Joseph R. Greenwood has become associated with Charles H. Higgins, Engineers and Architects, 165 Broadway, New York City.

J. G. Blunt, Superintendent of the general drafting room of the American Locomotive Co., Schenectady, N. Y., has been promoted to be Mechanical Engineer of the company.

E. K. Hall has resigned as Vice-President of the New England Telephone and Telegraph Co., Boston, Mass., to become Vice-President of the Electric Bond and Share Co., New York City.

A. L. Mathews has been elected a Vice-President of the J. G. White Management Corporation to take charge of a new department, which has been organized to manage sugar properties.

Harry W. Vetter has been appointed County Engineer of Warren County, New Jersey, succeeding Fred W. Salmon. He is a graduate of Lafayette College, class of 1911, and has been Assistant County Engineer.

James L. Kilpatrick, Assoc. Am. Inst. E. E., of the plant department of the Bell Telephone Co. of Pennsylvania, Philadelphia, Penn., has been appointed Engineer to succeed Nathan Hayward, resigned, as noted elsewhere.

H. C. Hearne, recently of the firm of the Samuel M. Green Co., Engineers and Architects, Springfield, Mass., has opened an office for private practice as Architect and Engineer, in the Third National Bank Bldg., Springfield.

R. M. Robinson, Jun. Am. Soc. C. E., has left his position with the Clinchfield (Ohio) Products Corporation to go with the Gifford-Wood Co., Hudson, N. Y. He was formerly with the Tennessee Copper Co., Copperhill, Tenn.

Spencer Cosby, M. Am. Soc. C. E., Lieutenant-Colonel, Corps of Engineers, U. S. A., Military Attaché of the American Embassy in Paris, has been ordered home. He will be succeeded by Capt. Carl Boyd, of the Third Cavalry.

Joseph E. Kuhn, Colonel, Corps of Engineers, U. S. A., has been nominated by the President to be Brigadier-General of the line, effective Jan. 2. Until recently General Kuhn was Military Observer with the armies of the Central Powers, at Berlin.

A. A. Miller has been appointed Engineer of Maintenance-of-Way of the Missouri Pacific Ry., with headquarters at Little Rock, Ark., succeeding R. C. White, resigned, as noted in these columns of last week. He was formerly General Roadmaster at Poplar Bluff, Mo.

L. T. Putman, Chief Engineer of the Christopher Coal Mining Co., Benton, Ill., and **C. B. Mautz,** former Assistant Engineer of the Chicago & Eastern Illinois R.R., at Danville, Ill., have formed a partnership under the firm name of Putman & Mautz, with offices at Benton.

Farley Gannett, M. Am. Soc. C. E., announces that he will hereafter conduct his practice together with his two associates, **Theodore E. Seelye** and **Samuel W. Fleming, Jr.,** under the firm name of Gannett, Seelye & Fleming, Consulting Engineers, 204 Locust St., Harrisburg, Penn.

Nathan Hayward, M. Am. Inst. E. E., has resigned as Engineer of the Bell Telephone Co. of Pennsylvania, Philadelphia, Penn., to become President of the American Dredging Co., Wilmington, Del. He is a graduate of the Massachusetts Institute of Technology and was formerly a member of its faculty.

Charles R. Rockwood, M. Am. Soc. C. E., who recently retired as Chief Engineer of the Imperial Valley irrigation district, is to be honored by the City of Calexico, Calif., by naming the city plaza Rockwood Plaza. In its infancy Mr. Rockwood presented the city with a block of land to be devoted to a public park.

George D. Marshall, Highway Engineer, United States Office of Public Roads and Rural Engineering, recently in charge of work at Austin, Tex., has been transferred to the Southern division of the Washington-Atlanta highway, Atlanta, Ga. This is one of the principal highways on which the Government is studying maintenance methods.

W. B. Davey, recently an Assistant Engineer with the New Orleans Sewerage and Water Board, has been appointed Assistant Engineer of the Orleans Levee Board, succeeding Edward R. Barnes, resigned. Mr. Davey was with the State Board of Engineers for three years prior to 1906, when he went to the New Orleans Sewerage and Water Board.

Harry F. Harris, Assoc. M. Am. Soc. C. E., recently Engineer of Streets, Department of Streets and Public Improvements, Trenton, N. J., has been appointed County Engineer of Mercer County, New Jersey. He has been connected with the city engineering staff of Trenton for 13 years, prior to which he was with the American Bridge Co. as a structural draftsman.

Crosby J. McGiffert, whose appointment as Acting Town Engineer of Montclair, N. J., was noted in these columns of last week, has refused to accept the appointment on the ground that no salary or term of office was stipulated. Mortimer E. Harrison, former Mayor and now a member of the city commission, will take charge of the engineering bureau of the town on Feb. 1.

Shirley Baker, M. Am. Soc. C. E., formerly Construction Engineer, **Edward Emery Carpenter,** M. Am. Soc. C. E., formerly Chief Civil Engineer, and **William Waters,** formerly Superintendent of Building Construction, of the Panama-Pacific International Exposition, announce that they have joined forces under the firm name of Baker, Carpenter & Waters, Consulting Engineers, 58 Sutter St., San Francisco, Calif.

Lee H. Powell has resigned as Division Engineer of the J. B. McCrary Co., Atlanta, Ga., to become Chief Engineer of Road District No. 1, Cherokee County, Texas, with headquarters at Jacksonville, Tex. It is proposed to construct 100 mi. of highways of local iron-ore gravel by a $200,000 bond issue; of this $50,000 will be reserved as a maintenance fund to be expended during the next five years.

John W. Reid has been appointed Engineer-in-Charge of the newly created Bureau of Grade Separation, Department of Public Works, Detroit, Mich. This bureau is a part of the organization of the office of the city engineer. Mr. Reid has served in the office of the city engineer during the past 17 years in various capacities, and his duties included the preparation of grade separation plans and estimates of damages. He was admitted to the practice of law in the State of Michigan in 1897.

R. M. Feustel, Assoc. M. Am. Soc. C. E., of Sloan, Huddle, Feustel & Freeman, Consulting Engineers, Madison, Wis., has been elected President of the Fort Wayne & Northern Indiana Traction Co., which includes the interurban lines from Fort Wayne to Lafayette and Bluffton and the local street railways of Fort Wayne, Logansport and Lafayette, Ind. Mr. Feustel was formerly Chief Engineer of the Wisconsin Railroad Commission. Recently he has been Consulting Engineer of the Bay State Ry., Boston, Mass.

David F. Crawford, M. Am. Soc. M. E., Superintendent of Motive Power of the Pennsylvania R.R. Lines West of Pitts-

burgh, has been promoted to be General Manager, with offices at Pittsburgh, Penn., succeeding Benjamin McKeen, promoted, as noted elsewhere. Mr. Crawford began his railway experience in 1880 as a clerk in the freight department of the Pittsburgh, Fort Wayne & Chicago R.R. Afterward he served four years as an apprentice in the Altoona shops of the Pennsylvania R.R. Since then he has advanced rapidly in the mechanical department.

George W. Fuller and **James R. McClintock**, M.'s Am. Soc. C. E., of the firm of George W. Fuller, Consulting Engineers, 170 Broadway, New York City, announce that they have admitted to partnership Jesse K. Giesey, Assoc. M. Am. Soc. C. E., and that the firm name hereafter will be known as Fuller & McClintock. Mr. Giesey graduated at Rensselaer Polytechnic Institute in 1904. He was a member of the staff of Hering & Fuller from 1904 to 1911; Assistant Engineer with Hering & Gregory from 1911 to 1914; and for the past 2½ years has been in charge of the construction of the outfall sewer, pumping station and sewage treatment works at York, Penn.

A. W. K. Billings, M. Am. Soc. C. E., has returned from Barcelona, Spain, where he has been for the past five years as Manager of Construction, Managing Director and Vice-President of the Ebro Irrigation and Power Co., Ltd., and allied interests, in responsible charge of extensive hydro-electric construction and other work. Over 110,000 hp. has already been developed, one interesting feature being the construction of the largest dam in Europe under very unusual conditions. Previous to his work in Spain and elsewhere for the Pearson interests, Mr. Billings spent two years in Pittsburgh and ten years in Cuba, principally on electric-railway and power-plant construction, and two years in New York as Engineering Manager of J. G. White & Co., Inc. He has opened an office as Consulting Engineer at 115 Broadway, New York City, and will devote considerable attention to work in Europe and in Latin America.

Benjamin McKeen, M. Am. Soc. C. E., General Manager of the Pennsylvania R.R. Lines West of Pittsburgh, has been promoted to be Fifth Vice-President, with offices at Pittsburgh, Penn. He was born in 1864. He attended Worcester Polytechnic Institute in 1881 and 1882 and then entered Rose Polytechnic Institute where he graduated in 1885 in mechanical engineering. After about a year as a mechanical draftsman with the Terre Haute & Indianapolis (Vandalia) R.R. he joined the field engineering staff of the railway as a rodman. From 1886 and 1887 he was Resident Engineer on construction of the Terre Haute & Logansport R.R. In 1889 he was made Chief Engineer of Construction of the Indiana & Lake Michigan R.R. He joined the operating staff in 1894 as Superintendent of the Peoria division of the Terre Haute & Indianapolis, and since then he was promoted steadily to the office of General Manager of the Pennsylvania Lines West on Jan. 1, 1913.

OBITUARY

Richard M. Pancoast, a retired civil engineer of Camden, N. J., died Jan. 5, aged 70 years.

William Miner, who made some of the first land surveys in the Black Hills country of South Dakota, died Jan. 4 at his home in St. Cloud, Minn., aged 71 years. He went to what is now Yankton, S. D., in 1860 and made the first survey there. Later he conducted a freighting business through the Black Hills.

Thomas Malcolm, a prominent railway contractor of eastern Canada, died at Campbellton, N. B., Jan. 10, aged 63 years. With the late John J. Macdonald he was contractor on the section of the Canadian Pacific Ry. around Lake Superior. Later with Messrs. Boswell and Ross he was contractor for the Temiscouata Ry. and other lines.

Charles C. Ramsey, President of the Crucible Steel Co. of America, Pittsburgh, Penn., one of the best known steel manufacturers in this country, died Jan. 11 from pneumonia. He was in his 55th year. He was born in Allegheny, Penn., and began his business career as a stenographer in the offices of the Pennsylvania Co. He was a member of the Engineers' Club of New York City.

James K. Ryan, senior member of the firm of Ryan & Keon, bridge and railroad contractors, Boston, Mass., died in St. Louis, Mo., Jan. 5. He was born in Brooklyn, N. Y., and some of his earliest work was the construction of the Brooklyn & Coney Island R.R. (now a part of the Brooklyn Rapid Transit Co.). Afterward he executed many contracts on the New York, New Haven & Hartford R.R. At the time of his death his firm had underway the construction of the Central bridge, Lawrence, Mass. He is survived by two sons, J. L. and C. J. Ryan, who are associated with their father's business.

Henry Gordon Stott, Past-President of the American Institute of Electrical Engineers, Superintendent of Motive Power of the Interborough Rapid Transit Co. and the New York Railways Co., died Jan. 15, at his home in New Rochelle, N. Y. He was born in Scotland in 1866 and received his technical education at what is now the Glasgow and West of Scotland Technical College. His engineering experience began in his native country as an employee of the local electric-light company at Glasgow. Shortly afterward he received an appointment with the Anglo-American Telegraph Co. as Assistant Electrician on the steamship "Minia," engaged in repairs to submarine cables. Leaving this position he became Assistant Engineer of the Brush Electric Engineering Co., of London. In September, 1891, he came to this country to take charge of putting in the underground cables and conduits of the Buffalo Light and Power Co., Buffalo, N. Y. On completion of this work he became Engineer of the company and built the power plant on Wilkeson St. On Mar. 1, 1901, Mr. Stott was appointed Superintendent of Motive Power of the Manhattan Railway Co., New York City, and ever since then has had charge of the motive power departments of the New York City (Manhattan) elevated and subway lines, and after the consolidation of all the transit lines he was made Superintendent of Motive Power of the surface lines, the New York Railways Co., also. He was the author of many papers and articles on power engineering. He was a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers and of the Engineers' Club, New York. A more complete biography and a portrait were published in "Engineering News" of Jan. 23, 1908, at the time of his election to the presidency of the American Institute of Electrical Engineers.

ENGINEERING SOCIETIES

WESTERN BRICK MANUFACTURERS' ASSOCIATION.
Jan. 20. Meeting in Kansas City, Mo. Secy., G. W. Thurston, 416 Dwight Building, Kansas City.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 23-25. Annual meeting in Montreal, Can. Secy., C. H. McLeod, 176 Mansfield St., Montreal.

ILLINOIS SOCIETY OF ENGINEERS.
Jan. 25-26. At Chicago. Secy., E. E. R. Tratman, Wheaton, Ill.

NORTH DAKOTA SOCIETY OF ENGINEERS.
Jan. 30-31. Annual meeting in Bismarck. Secy., E. F. Chandler, University, N. D.

OHIO ENGINEERING SOCIETY.
Jan. 31-Feb. 2. Annual meeting. Ohio State University, Columbus, Ohio. Secy., John Laylin, Norwalk, Ohio.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

NATIONAL LIME MANUFACTURERS' ASSOCIATION.
Feb. 6-7. Annual meeting in New York City. Secy., F. K. Irvine, 537 South Dearborn St., Chicago.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 7-9. Midwinter convention in New York City. Secy., F. J. Hutchinson, 33 West 39th St., New York City.

MINNESOTA SURVEYORS' AND ENGINEERS' SOCIETY.
Feb. 7-9. Annual meeting in Minneapolis.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

AMERICAN ASSOCIATION OF ENGINEERS.
Feb. 8-10. In Chicago at the Hotel La Salle.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 14-15. Annual meeting in Indianapolis. Secy., W. F. King, Indianapolis, Ind.

WISCONSIN ENGINEERING SOCIETY.
Feb. 15-16. At Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 19-22. Meeting in New York City. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb 20-21. Annual meeting in New Haven in Mason Laboratory. Secy., J. F. Jackson, New Haven.

IOWA STATE DRAINAGE ASSOCIATION.
Feb. 20-21. Meeting in Fort Dodge. Secy., M. F. P. Costelloe, Ames.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting in Ames. Secy., J. H. Dunlap, Iowa City.

The Association of Ontario Land Surveyors will hold its annual meeting on Feb. 20 in Toronto. The secretary is L. V. Rorke, Toronto.

The New England Association of Gas Engineers will hold its forty-seventh annual meeting Feb. 14 and 15 in Boston at the Copley Plaza Hotel. The secretary is N. W. Gifford, 38 Central Square, East Boston.

The American Society of Engineering Contractors will hold its annual meeting Jan. 19 and 20 in New York City at the Hotel Marlborough. At the banquet, on Jan. 20, motion pictures will be shown of some large construction work.

The Engineers' Society of Western Pennsylvania at its annual meeting on Jan. 9 elected the following officers: Chairman, George W. Nicholas; vice-chairman, R. A. Pendergross; secretary, Edward R. Dasher, 41 South Front St., Harrisburg, Penn.

Appliances and Materials

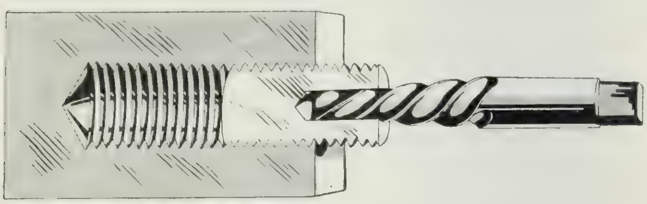
Self-Rotating Hole-Cleaning Hand Hammer Drill

A self-rotating hand hammer drill that automatically cleans the drilled hole has just been placed on the market by the Wood Drill Works, of Paterson, N. J. If the air going through the hollow steel does not clean the hole, as will be the case in certain rocks, a button at the top of the chest can be pushed to apply full air pressure to the drill point. When the button is released, the drill automatically starts again. The drill is self-oiling and has a soft-rubber grip on the handle to reduce the transmission of vibration to the operator.

* * *

Broken-Screw Extractor

One of the most ingenious and useful, but simple, tools made in recent years is the "Ezy-out" extractor for broken stud bolts, setscrews, etc., just announced by the Cleveland Twist Drill Co., Cleveland, Ohio. It is shown in the accompanying sketch. A hole is bored in the shank of the broken screw, and the tool is stuck in and twisted left hand. The left-hand, coarse, helical threads of the tool grip the sides of the bored hole and back out the old screw. A set of "Ezy-outs" consists of three tools of different sizes, which it has been found will meet the requirements of an ordinary shop or contractor.

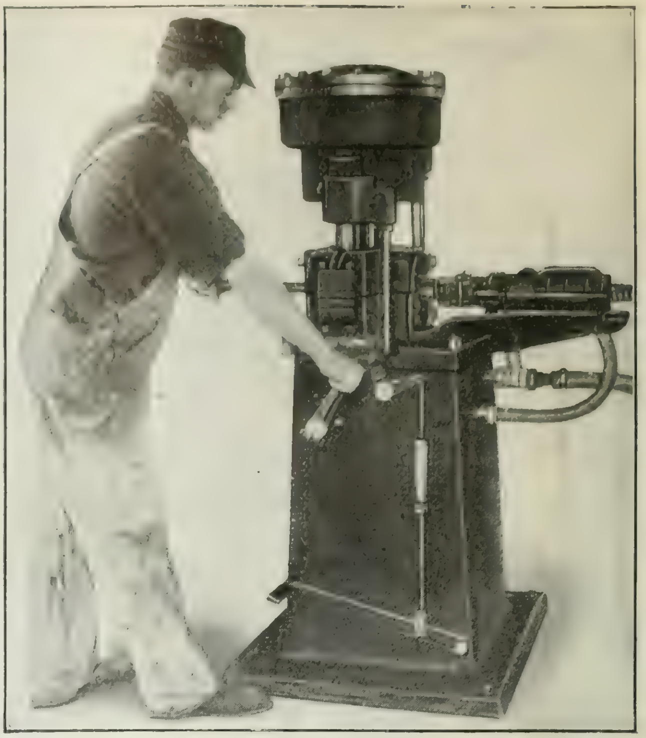


BROKEN SCREW EXTRACTOR

* * *

Convenient Drill Sharpener

A new pneumatic drill sharpener has just been placed on the market by the Denver Rock Drill Manufacturing Co., of Denver, Colo. It is known as "Model DS-8" and has a pneumatic dolly and a swaging ram, mounted on a single pedestal. The ram cylinder is located directly above the die block, and the manufacturer claims that this arrangement is largely responsible for the effectiveness of the machine under low pressure.



NEW DENVER DRILL SHARPENER

The ram piston not only operates the swaging die, but is also used for clamping the steel when dollying, and it operates a steel cutter that is set at one side. The pin-pulling attachment, shown at the side of the pedestal, is operated by a pedal.

The exhaust is muffled in the hollow base. The dollying hammer is of the valve type; the changing of dollies is a simple operation, as there is no back pressure of the plunger when the hammer is not in operation. The machine is entirely controlled by a single lever, actuating two separate valves.

* * *

Steel Drafting-Room Furniture

A new type of construction has been devised by the Economy Drawing Table Co., of Toledo, to offset the increase in cost of material and to enable steel drafting-room furniture to be sold under prevailing prices. All joints are welded. The regular line includes drawing tables (with soft-pine top and filing drawers) and filing cases. Special designs are also made.

* * *

Three-Wheeled Dumping Trailer

The "Trakker-wagon," built by the A. W. Benson Manufacturing Co., Minneapolis, Minn., is a steel trailer designed especially for road-construction work. The accompanying view shows three of these trailers drawn by a small tractor. The bogey carrying the front-wheel journals also has coupler jaws, and a string of these wagons follows the tractor path. The bodies are bottom-dumping, and the leaves are hinged on the side frames. A handwinch with ratchet and pawl is mounted on the front for closing the bottom.

TRAIN OF TRACTOR AND THREE-WHEELED DUMPING TRAILERS

Engineering News

VOLUME 77 JANUARY 25, 1917 NUMBER 4

Huge Chicago Freight Station for Pennsylvania Lines

The extensive railway-terminal improvements at Chicago in connection with the construction of the new Union Station include a very large combined freight station and warehouse for the Pennsylvania Lines.

To make way for the development of the passenger station it was necessary to abandon certain freighthouses of the P., Ft. W. & C. Ry., and in planning the new freight terminal it was arranged to concentrate all the downtown less-than-carload business of this road in one large freight station. The building is about 750x420 ft. in plan, extending between Polk and Taylor St. and lying between the main tracks and the river.

On account of the extremely high cost of property in this vicinity and the desirability of utilizing the available space to the best advantage it was decided to build a two-level freighthouse with three upper floors for warehouse and storage purposes. South of the station will be large team yards, with 50-ft. roadways of 2.3% grade to connect the yard driveways with Taylor St. The plans at track level and street level are shown in Fig. 2, while Fig. 3 shows the general design and arrangement of the building.

The railway tracks are in the basement, at main-track level, while one of the outside tracks passes under a corner of the building. There will be 19 stub tracks in the building, arranged singly and separated by trucking platforms 5½ to 27 ft. wide. The ten tracks (with nine platforms) on the east side are for outbound business and have capacity for 199 cars. The nine tracks (and nine platforms) on the west side are for inbound business and have capacity for 176 cars. These tracks converge in groups, which again converge into a three-track approach. In this fan-shaped approach layout No. 8 frogs and 13° curves are used.

On either side of this approach will be a team yard with stub tracks in pairs, separated by driveways. The yard on the east (outbound) side will have capacity for 206 cars, while that on the west (inbound) side will have capacity for 197 cars. South of the approach will be storage tracks having a total capacity for 117 cars.

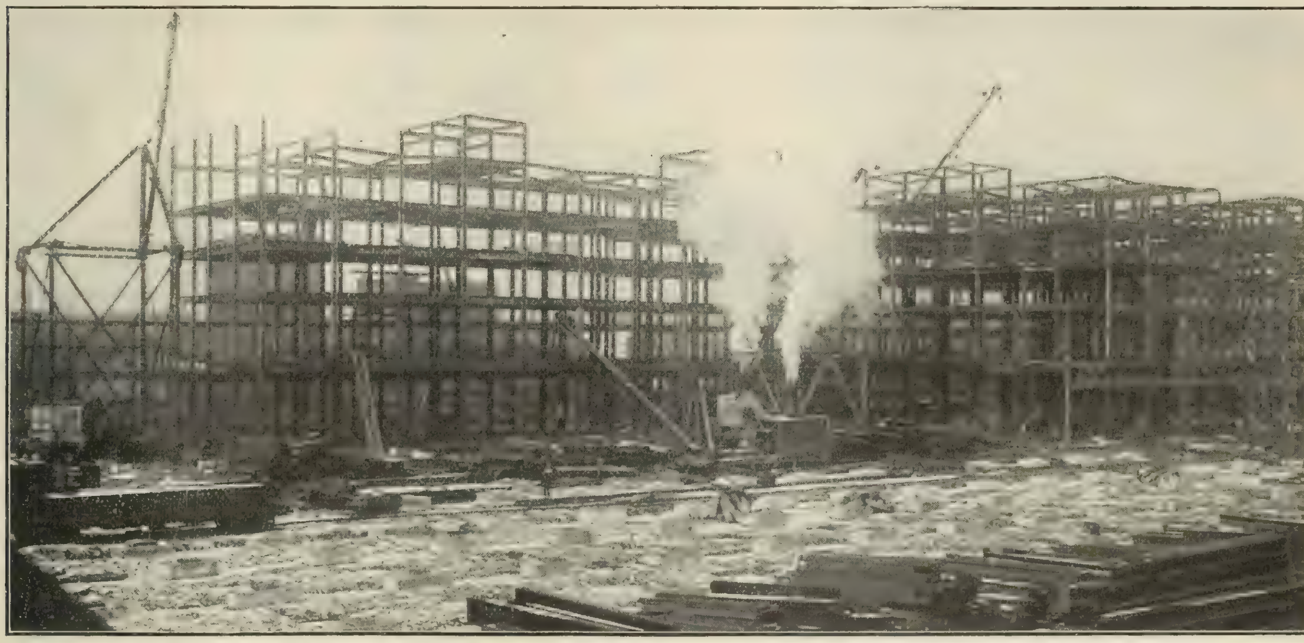


FIG. 1. ERECTION OF THE STEEL FRAMING FOR THE CHICAGO FREIGHT TERMINAL OF THE PENNSYLVANIA SYSTEM

There will be 17,000 tons of structural steel

The first floor (for teams), or main freighthouse floor, will be at the street level, the streets being carried across the tracks by viaducts. At its east side will be the outbound house, 100 ft. wide, and on the west side the inbound house, 170 ft. wide. These are separated by a 76-ft. space divided into two 38-ft. driveways. On the outer side of each house also is a 38-ft. driveway. All these driveways are covered throughout their entire length.

Above this main freighthouse floor the building is carried up for three stories over the inbound and outbound houses and central driveway. This area is 745x343-ft. Six light courts 40x153½ ft. are located over a portion

of the inbound house and central driveway. The general freight offices will occupy the north (Polk St.) end of the second floor. At this end also will be a tower 50 ft. square and 180 ft. high above the street level, with a 16-ft. clock face on each side of the tower.

At the north end of the outbound house will be a sub-basement about 66x72 ft. to accommodate the heating plant and other mechanical apparatus. At one side of this will be a coal bin and ash bin, crossed by a track for cars. This sub-basement will have heavy retaining walls and a reinforced-concrete floor about 5 ft. thick. It will be covered at the track-floor level by a framing of I-beams embedded in a concrete slab.

An extensive equipment of electric freight elevators will serve the several floors and platforms. There will also be two elevators connecting (through oval shafts) with the Chicago Tunnel Co.'s narrow-gage electric freight-railway system, the tunnels of which pass under the station. These elevators will be large enough to carry the tunnel cars. The total equipment, exclusive of the tunnel elevators, will comprise 50 elevators, and 32 of these will form the first installation.

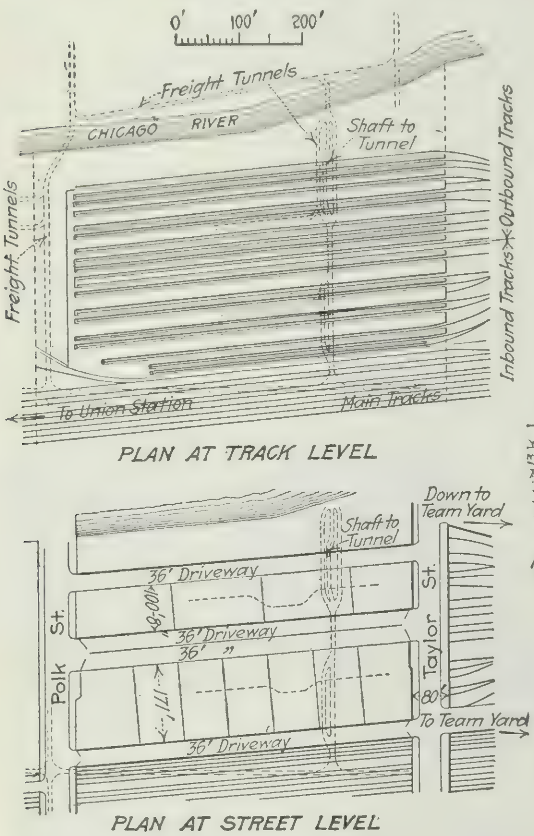


FIG. 2. PLAN OF PENNSYLVANIA FREIGHT TERMINAL

Structural Design of Building

The building is of steel-frame construction with reinforced-concrete floors and roof, and brick curtain walls. All the steelwork is incased in concrete fireproofing, the concrete being secured by wire netting wrapped around the steel. On the columns the minimum thickness of concrete is 3 in. There are about 17,000 tons of structural steel in the building.

The columns are of H-section, built up of side and web plates with four interior angles. The typical floor framing is shown in Fig. 4. On the first floor the main framing in the freighthouse portions consists of transverse 24- to 30-in. plate girders and 24-in. I-beams, and longitudinal lines of 24-in. I-beams. The central and side driveways are carried by transverse 19½-in. and 34-in. plate girders spaced about 7 ft. apart. The upper floors have generally similar framing, except that there are no driveways to be carried and 24-in. I-beams are used mainly, both in the wings and the transverse portions. Girders are placed where the intermediate columns of the upper floors have to be supported above the central driveways.

At the second-floor level are the roofs over the side driveways, carried by transverse 18-in. girders and I-beams spaced 7 ft. apart. At the same level are the roofs in the light courts, over the freighthouse floor. They have high triangular skylights, partly in one span and partly in two spans. Inclined skylights are placed along the corner between the driveway roof and building, and saw-tooth skylights are used in some places. The skylight sash is all hinged at the upper edge, to provide for ventilation.

The floor bays are of various sizes, from 14x20 and 14x25 ft. to 20x20 and 20x25 ft. The first, or main freighthouse, floor has a concrete slab 8 to 11 in. thick (in different bays), including a 1½-in. mastic finishing coat. In the three warehouse floors the concrete slab is 8¾ to 10 in. thick, with a 1-in. special cement finish. The main roof slab is 5½ to 6 in. thick, while the roofs over the outside driveways have a 3½-in. slab. Each floor bay has rectangular reinforcement with diagonal lines of bars between the corners, as shown in Fig. 6.

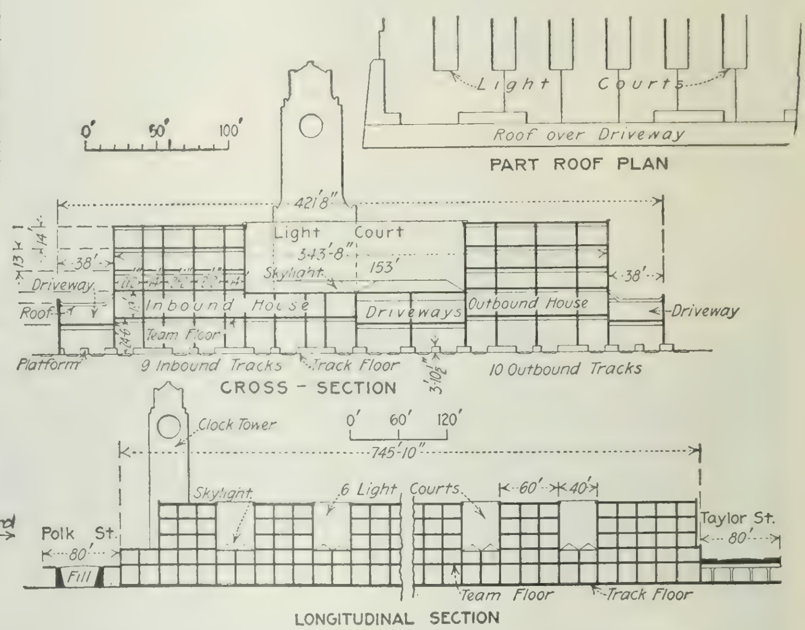


FIG. 3. SECTIONAL ELEVATIONS OF PENNSYLVANIA TERMINAL

The floor loads are as follows: First floor (freighthouse), 300 lb. per sq.ft.; second floor (warehouse), 250 lb.; third and fourth floors (warehouse), 200 lb.; tower floor (offices), 125 lb.; roof, 30 lb. The driveways are designed to carry 24-ton motor trucks.

The column shoes are seated on I-beam grillages in rectangular concrete pedestals. Some of these pedestals carry individual columns and have their own footings. Others are carried on long footing walls. The arrangement of the footings is irregular, in order to suit the column spacing and to provide for openings, etc. In the east

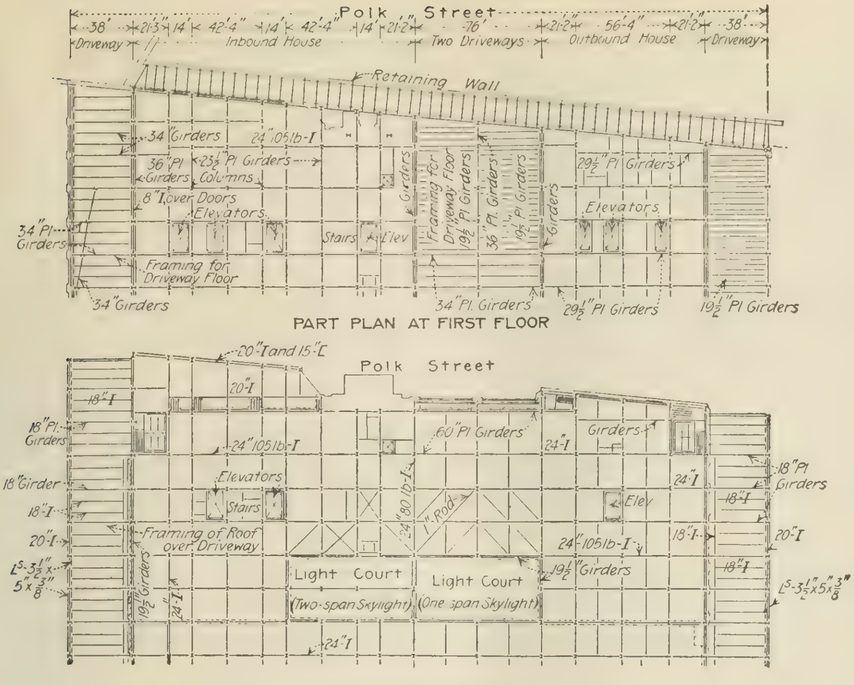


FIG. 4. STEEL FRAMING PLANS OF FREIGHT TERMINAL

was limited by the fact that several of the tunnels of the Chicago Tunnel Co. pass under the site, as noted above. The piles were not pointed or shod. They were driven by steam hammers. In order to determine the settlement, test piles were driven, and each was loaded with 40 tons of pig iron. The total settlement in 11 days was 0.034 in. to 0.067 in., and after that time there was no further movement. The foundation concreting over the entire area was done by spouting from the towers of two stationary concrete-mixing plants. Materials were delivered on cars and elevated to storage bins over the mixers. The cement was handled in bulk. From the box-cars it was shoveled into the hopper of a screw conveyor, which delivered it to an elevating conveyor discharging into the bin. The sand and stone were placed in the bins by means of electrically operated derricks. From the bins the materials were delivered to a measuring hopper divided into three compartments for automatically separating the proportions. The concrete is a 1 : 2 : 4 mix.

portion of the building the footing walls run in a longitudinal direction, while in the west portion they run transversely.

The footing walls are 11½ to 17½ ft. wide on the base, and 6 ft. deep. Their sides are vertical for about 3 ft. from the base and then slope inward toward the top. They are reinforced with steel bars. Typical details of the foundations are shown in Fig. 6, and a view under construction in Fig. 5.

All the footings are carried on 40-ft. timber piles driven into the stiff, blue, Chicago clay. The length of the piles

From the mixer the concrete was discharged into the bucket of an elevator tower and then dumped into a hopper at the head of the spouting. From the main tower, lines of rigid trussed spouting extended about 50 ft. to secondary towers, beyond which were lines of flexible spouting supported partly by cables from these towers and partly by timber frames and horses.

The erection of the steelwork was done by means of large tower derricks traveling on tracks on the ground

FIG. 5. CONSTRUCTION OF THE CONCRETE FOUNDATIONS FOR THE CHICAGO FREIGHT TERMINAL OF THE PENNSYLVANIA SYSTEM

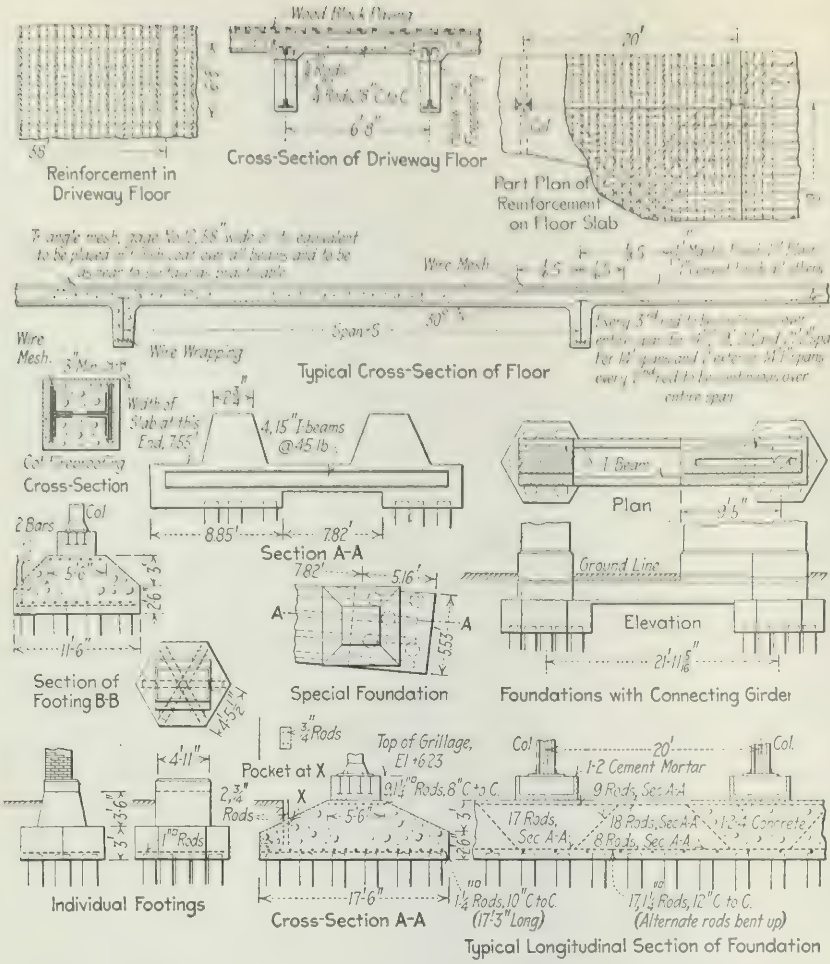


FIG. 6. DETAILS OF FOUNDATIONS AND FLOORS OF FREIGHT TERMINAL

level. Each had a rectangular timber tower surmounted by a stiff-leg derrick, the boom being thus at sufficient height for placing the roof framing. These derricks were described in *Engineering News*, Oct. 26. The steel was unloaded from cars and stacked and rehandled on the site by a steam-derrick car. The framing for the west half of the building was erected first, and Fig. 1 shows this part of the structure almost completed. As a protection for the workmen, each floor had a temporary plank decking, as required under the Illinois law providing for safety methods in construction work. As the height from the ground to the second floor was 43 ft., all floors had to be decked; but where the height does not exceed 32 ft., the law permits the decking to begin at the second floor. The steel erection of the portion of the structure as shown in Fig. 1 was practically completed and ready for concreting in June, 1916, but work was stopped by a general strike.

Contractors and Engineers

The Blome-Sinek Co., of Chicago had the contract for the foundation piling and concrete substructure. The Thompson-Starrett Co. had the contract for the structural steel, which was fabricated by the McClintic-Marshall Co. and erected by the Kelly-Atkinson Construction Co. The George A. Fuller Co. has the general contract for the superstructure, and the concrete floors and roof will be placed by O. W. Rosenthal & Co. All the above principal contractors are Chicago firms. The design and construction of this freight terminal were under the direction of Thomas Rodd, Chief Engineer, and Robert Trimble, Chief Engineer of Maintenance-of-Way, Pennsylvania Lines.

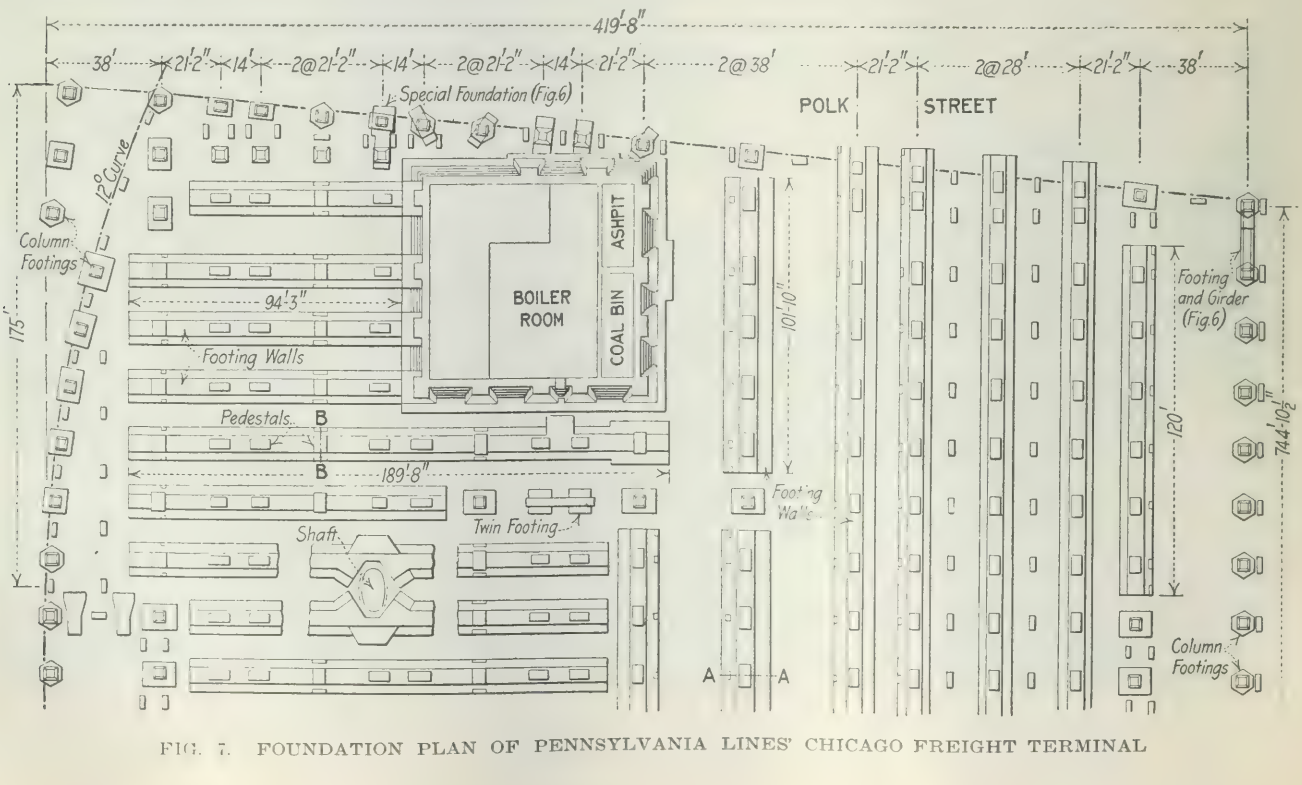


FIG. 7. FOUNDATION PLAN OF PENNSYLVANIA LINES' CHICAGO FREIGHT TERMINAL

Harrisonburg Imhoff Tanks

By William G. Myers*

Harrisonburg, Va., has just completed two rectangular Imhoff tanks and sludge-drying beds to serve a population of 5000. Intermittent sand filter beds will be installed later. Fig. 2 is a general view, and Fig. 1 shows sections of the tanks.

The side walls of the tanks are built of reinforced concrete and are braced transversely with 8-in. I-beams (Fig. 1). These I-beams also support footways and curtain walls. The precision with which these curtain walls were built was notable.

A peculiar feature of the design is the arrangement of the inlet and outlet pipes. These pipes are inverted siphons, entering the bottom of the concrete tunnel around the tank. They are "staggered" so that an 8-in. wall can be built between them. This wall is provided with ordinary channel irons set in the concrete as guides for two drop gates shown in Figs. 1 and 2, so that the direction of the current may be readily changed from one end of the tank to the other.

The bottom of the concrete tunnel is horizontal longitudinally, which admits of symmetrical and cheaper construction and has a further advantage in that a "scouring current" is maintained in both inlet and outlet conduits.

Another feature, due entirely to local conditions, was the necessity of building a retaining wall to take the earth thrust on the east side of the tank. This wall was of the reinforced buttress type (Fig. 1), but the footing was not carried to the full depth of the tank and was placed only halfway down, opposite a row of I-beams spanning the tank at this point. In the design some dependence was had in the thrust of the I-beams and in the beam or arch action of the footing of the retaining wall.

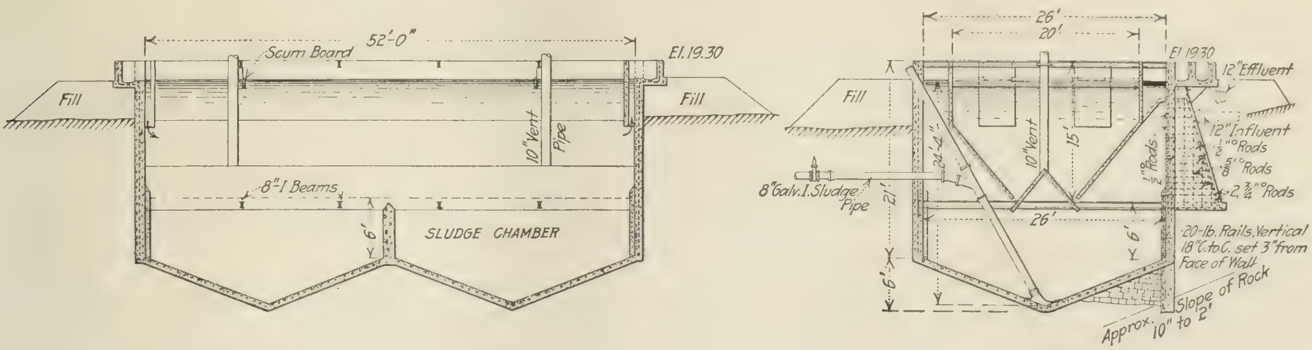


FIG. 1. LONGITUDINAL AND CROSS-SECTION, IMHOFF TANKS, HARRISONBURG, VA.

The inlet pipe is provided with a storm-water bypass and a weir by which the amount of sewage entering the tank may be determined. About 25% of this sewage is tannery waste impregnated with insoluble tannates. The consequent discoloration is not eliminated by the tank.

The whole work was done at a cost of $6757 by force account under J. F. Noll, superintendent of public works; William G. Myers, city engineer; and N. Wilson Davis, consulting engineer.

FIG. 2. VIEW OF IMHOFF TANKS AND CORNER OF SLUDGE-DRYING BEDS, HARRISONBURG, VA.

*City Engineer, Harrisonburg, Va.

Motor-Driven Vehicles are to be substituted for horse-drawn carts and wagons in the street-repair and ash- and rubbish-collection divisions of the Cleveland, Ohio, street department. Council committees have voted $68,000 to buy machines, including a large motor truck for garbage collection in the downtown section and two for hauling garbage from the downtown collection station to the reduction plant.

Scoring Water-Supply Quality*

By Theodore Horton† and E. Sherman Chase‡

In connection with the work of the Engineering Division of the New York State Department of Health in supervising public water-supplies of that state it was considered desirable that some convenient method of rating the sanitary character of public water-supplies according to a definite quantitative measure should be worked out, and our endeavor in this direction led to the following study.

There are three factors or measures that may be considered as fundamental in rating the sanitary quality of a water-supply: Contamination on the watershed; natural agencies or artificial means tending to counteract or correct this contamination; and the efficacy of these agencies as determined by laboratory analyses.

In making this study it was found that the water-supplies of New York State could be classified according to three groups, as follows: (1) Surface supplies, excluding supplies from the Great Lakes, the Niagara and St. Lawrence Rivers; (2) supplies from the Great Lakes, the Niagara and St. Lawrence Rivers; (3) groundwaters. In each group, however, the same general formula was applied, which was expressed as follows:

$$S = \frac{A}{B - C}$$

in which

S = "Score" representing the sanitary quality of the supply on a 100% scale;

A = Factor representing the condition of pollution of the watershed;

B = Factor representing natural or artificial means of purification or protection against pollution;

C = Factor representing the efficiency of this purification in the nature of a penalty based on the prevalence of B. coli in the water as delivered.

The following is a summary of the method of scoring that has been tentatively adopted for this study.

Group 1—Surface Water-Supplies

Factor A—Values for this factor are to be taken from the curve of population per square mile, the values ranging from 60 for an unpopulated watershed to 0 for a population of 1,000 per sq.mi. The figures for population per square mile in this case are to be made up of the sum of the population contributing sewage directly and indirectly, the population contributing directly being first multiplied by 5.

Factor B—Values for this factor will depend upon the means of purification, as follows:

Slow sand filters	20
Sterilization	15
Gravity mechanical filters	15
Pressure mechanical filters	10
Storage (2 weeks)	10
Storage (1 week)	5

For combined methods of purification add individual scores, but allow no greater than 10. Deduct 5 in case no coagulant is used with mechanical filters.

Factor C—This is based on a penalty for B. coli results, thus:

	Deduct
B. coli present in 100% 10 c.c. samples	10
B. coli present in 100% 1 c.c. samples	20
B. coli present in 100% 1/10 c.c. samples	30

B. coli present in other percentages deduct proportionally.

Group 2—Great Lakes, Niagara and St. Lawrence Rivers

Factor A—In assigning values for this factor consider that a population of 100,000 discharging sewage into the

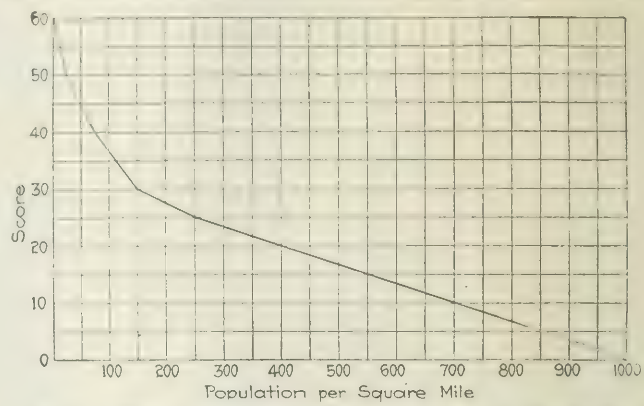


FIG. 1. POPULATION FACTOR CURVE FOR SCORING QUALITY OF NEW YORK WATER-SUPPLIES

body of water within one mile of the intake is equivalent to a population of 1,000 per sq.mi. and that the danger from such pollution is inversely proportional to

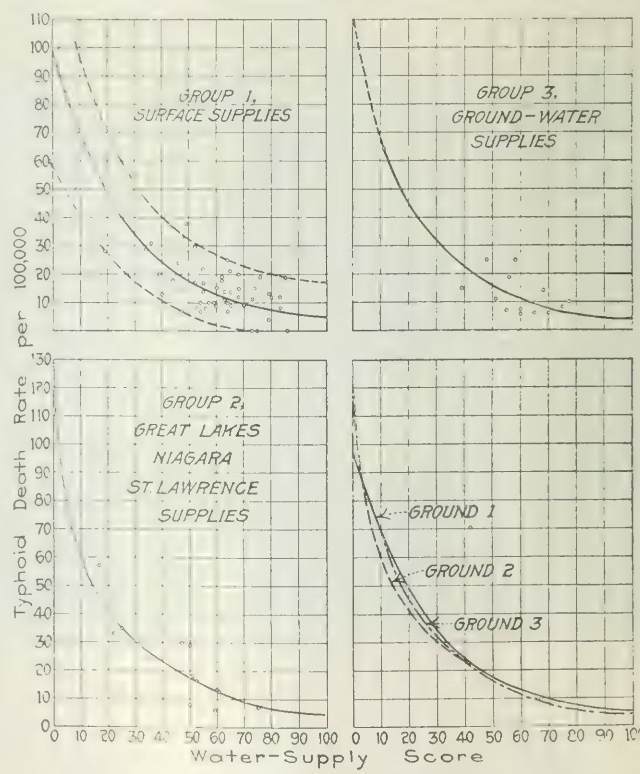


FIG. 2. WATER-SUPPLY SANITARY SCORES AND TYPHOID DEATH RATES IN SOME 90 NEW YORK MUNICIPALITIES

the distance beyond one mile. In case of the lake supplies consider also that the limits at which pollution will affect the supply is 20 mi. In the case of the rivers all pollution reaching the river and affecting the supply is

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*Abstract of a paper entitled "A Study of the Application of the Score System to the Sanitary Quality of Public Water-Supplies in New York State," presented before the Sanitary Engineering Section of the American Public Health Association, October, 1916.

†Chief Engineer, New York State Department of Health, Albany, N. Y.

‡Assistant Engineer, New York State Department of Health, Albany, N. Y.

to be considered. The equivalent population per square mile will then equal

$$\frac{P}{100 \times D}$$

in which

P = Population discharging sewage;

D = Distance from intake in miles.

Factor B—Purification as with Group 1.

Factor C—Analytical penalty as with Group 1.

Group 3—Groundwater Supplies

Factor A—In assigning values for this factor each source of pollution within 100 ft. is to be considered equivalent to a population of 20 per sq.mi.; beyond 100 ft. and within 500 ft. equivalent to 10 per sq.mi.; and beyond 500 ft. and within 1,000 ft., equivalent to 5 per sq.mi. Use curve for Group 1 in determining factor A.

Factor B—The value for this factor will depend upon the natural character of the material in which the springs or wells are located, as follows:

Sand	40
Loam	35
Clay	30
Fissured rock and gravel	25
Solvent rock	20

If artificial means of purification are used, assign values as for Group 1.

Factor C—The penalty for B. coli results is to be double that of Group 1.

Relation Between Scores and Typhoid Death Rates

Some 90 public water-supplies in New York State have been scored, and results have been plotted in curves to show the relation between the scores and the typhoid-fever death rates. The curves for the score of the three groups were plotted independently and then superimposed with results shown in Fig. 2. The practical coincidence of the three curves indicates the approximate correctness of the values assigned for the various factors used in the general formula for scoring.

In conclusion it should be stated that the foregoing study for a score system of the sanitary quality of public water-supplies is presented as tentative only and that the figures assigned for the different factors are, for the time being, merely a suggestion. The scores actually obtained, however, correspond in a general way so closely with the knowledge of the sanitary qualities of the supplies secured through field investigations and compare so closely with the typhoid-fever death rates as to convince one of the practicability of the application of the score system to the water-supplies of New York State. A continuation of studies in connection with this score system will, no doubt, permit such modification in the values of the several factors as will make the final scores even more consistent with the knowledge of the quality of the supplies and the corresponding typhoid-fever death rates.

Increased Production of Hydrated Lime—An estimate of lime produced and sold in 1916 in the United States, including Porto Rico and Hawaii, just made by G. F. Loughlin, of the United States Geological Survey, Department of the Interior, indicates a total marketed production of 4,150,000 short tons, a gain of nearly 15% over the total for 1915, which was 3,622,810 short tons. This is the first year in which the production of lime in this country has equaled or exceeded 4,000,000 tons. Hydrated lime in 1916 showed an even more striking increase than total lime, the marketed production amounting to 710,000 tons, a gain of more than 13%. All states in which the production amounted to 5000 tons or more showed increases. These states included Michigan, Illinois and Washington, in which the total production of lime decreased.

The Late Sir Hiram Stevens Maxim

Each of the British technical journals, the *Engineer* and *Engineering,* devotes a page or more to an account of Sir Hiram Maxim, who died on Nov. 24, 1916, and who gained world-wide fame through his achievements as an inventor.

Maxim was born on a farm at Sangerville, Maine, in 1840. He was apprenticed to a wheelwright at the age of 14, and after his apprenticeship ended led a more or less roving life, engaging in various occupations, including that of a prize fighter. He also worked for a maker of scientific instruments, for a New York shipbuilding concern and for Oliver P. Drake, of Boston, a maker of gas machines. While at the latter place, Maxim invented a machine for making artificial gas from gasoline vapor, which had an extensive sale. When electric lighting attracted wide attention in the late '70's, inventors everywhere were engaged on the problem of making lamps of low candlepower to supplement the arc lamp. Maxim was a competitor of Edison as a pioneer in developing the incandescent lamp, and several processes in its production, notably the flashing of the filaments in hydrocarbon vapor, were devised by him.

In 1881 Maxim went to the Paris Exposition, representing an American electrical company of which he was chief engineer. Up to that time the numerous inventions which he had made in his native country had yielded him little in the way of return.

It was while in Paris that his attention was directed to military inventions. He made rough sketches illustrating his idea of a machine gun; and while the idea was in embryo and before any complete drawings were made, he was introduced to Albert Vickers, one of the leading British manufacturers of guns and munition. Vickers at once recognized the value of Maxim's invention, and a partnership was formed by Vickers, Maxim and Symon, vice-president of the Mexican Central Ry., who had introduced the two men to each other.

This was the turning point in Maxim's career. He settled in England, disowned allegiance to his native country, whose unjust treatment of inventors he was never tired of condemning, and devoted himself to the development of his gun and kindred inventions.

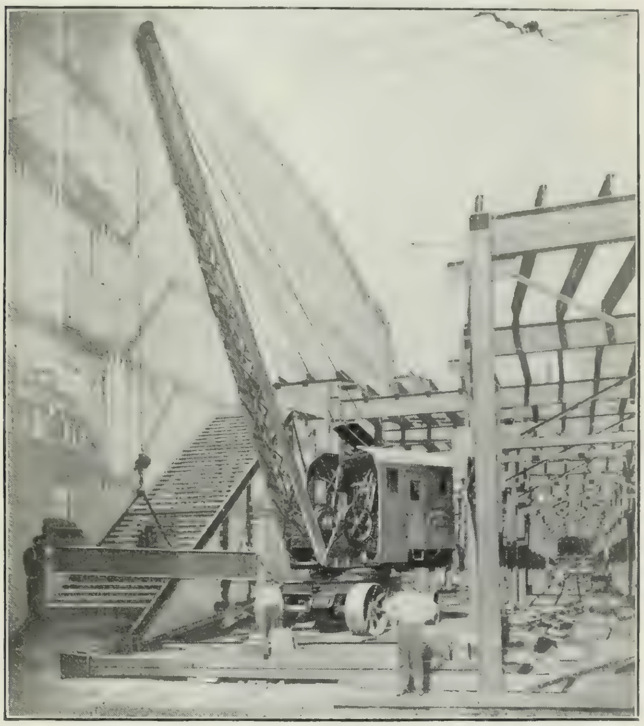
There had been, of course, numerous machine guns prior to Maxim's invention. The central idea on which Maxim worked, however, was to make the force of the explosion operate the breech mechanism, so that when an occasional cartridge hung fire for a fraction of a second, the block would not open until the explosion had actually taken place. It was not possible to patent this broad principle, as some suggestion of it had been published previously, although it had never been applied in practice. Maxim, however, surrounded his gun with a fence of detail patents so that for many years his firm had a practical monopoly of the business at immense profits.

Maxim later turned his attention to explosives, and some of the important work in the early development of smokeless powder is ascribed to him. In 1894 he made some spectacular experiments to determine the lifting effect of airplanes in connection with the problem of mechanical flight. He constructed an ingenious steam power plant developing some 360 hp., with a total weight of less than 3,000 lb. This engine drove two huge pro-

pellers 18 ft. in diameter, which in turn drove a car forward on a straight track. The planes attached to the car tended to lift it as it was propelled forward, but overhead rails prevented it from actually lifting off the rails. The experiment attracted wide attention, and on the strength of it Maxim claimed to be one of the pioneers in the development of the flying machine.

Extending Cincinnati Approach to the Covington Bridge Over the Ohio

The Covington and Cincinnati suspension bridge across the Ohio River between the cities named has entered Cincinnati on a comparatively low level through a district that is often flooded at times of high water. In order to relieve this condition and, in addition, provide



GASOLINE-DRIVEN CRANE HANDLING STEEL ON CINCINNATI BRIDGE APPROACH

an approach for vehicles nearer the business district a new approach is now under construction. It consists of a full-width steel viaduct with concrete roadway continuing the present line of the bridge on high level up to Third St. for the vehicle roadway and to Fourth St. for the street-railway tracks. The present highway approach reaches only to Front St. and the street-railway tracks to Second St.

The new viaduct, shown under construction in the accompanying view, is on a private right-of-way inside the regular city block and is over territory from which buildings have just been removed. The street-railway line will continue to a terminal now being built at the corner of Fourth and Walnut St.

The accompanying view also shows a gasoline-engine-operated locomotive crane fitted with wide tractor-type wheels for running over city streets. It was built by the Industrial Works, of Bay City, Mich., and used with success by the American Bridge Co. in the steel erection of the new bridge approach.

Building an 8-In. Macadam Pavement with a Tar and Gravel Top

By Henry Marshall Olmstead*

An 8-in. waterbound macadam road, constructed in two courses, carpeted with a surface of tar and pebbles, is a type of construction that is giving satisfaction in some New Jersey communities. This construction, described in detail in the succeeding paragraphs, costs about \$1 per sq.yd., or \$10,570 per mi., for an 18-ft. road: and it is estimated that it can be maintained for less than \$300 per mi. per yr.

The pavement described contained 21,500 sq.yd., was 30 ft. wide except for about 800 ft. of 35-ft. width, and was about 6000 ft. long. It was constructed in the sum-

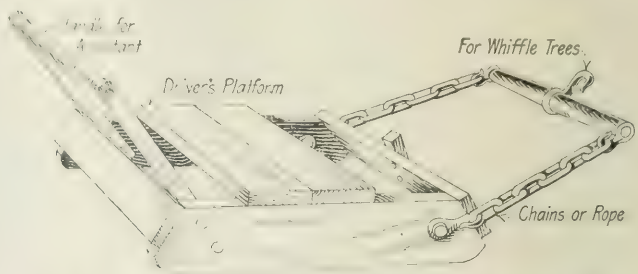


FIG. 1. SPREADER FOR BROKEN STONE MACADAM ROAD BUILDING

mer of 1916 in Bayonne Park, Bayonne, N. J. The pavement was provided with tile drains and cobble gutters, the cost of which is not included in the figures given.

The earth subgrade was given a 3-in. crown. The first course was of $2\frac{1}{2}$-in. stone 3 in. thick at the gutters (edge), 4 in. at the shoulders and 5 in. at the crown. The top course of $1\frac{1}{2}$-in. stone was of a uniform depth of 3 in., making the completed pavement 6 in. thick at the gutters, 7 in. at the shoulders and 8 in. at the crown. All dimensions refer to rolled depths. The stone was Rockland Lake (N. Y.) trap rock.

Special Device for Spreading Stone

As a rule, the wagons and motor trucks aided in spreading the stone. Shovels and stone rakes were used. At times conditions necessitated dumping stone in piles, in which case a special stone leveler (see Fig. 1) was used. This leveler was made as follows: There were two runners of $1\frac{1}{2}$x12-in. plank 5 ft. long, with rounded and beveled ends, as shown in the illustration. To the beveled ends were nailed pieces of $1\frac{1}{2}$-in. plank 7 ft. long and 10 in. wide. The bottom of these end planks came 2 in. above the level of the runners. The front end served as a plow, but allowed the stone to "flow" under its front edge. To facilitate the plowing action a 2x4-in. stake was nailed to the front piece, as shown. The driver stood on a plank platform nailed to the tops of the runner planks. The team was attached to whiffletrees by a crossbar and a pair of chains 4 ft. long.

On a measured area (1000 sq.yd.) irregular piles of stone in heaps, 1, 2 and 3 ft. high were spread and leveled to a 4-in. depth in 3 hr. at a cost of \$2.10. With hand spreading this would have taken 20 men 9 hr. and cost \$40. To guide the workmen, wood blocks 4, 5

*Highway Engineer, 15 Butler Place, Brooklyn, N. Y.

and 6 in. high were used to gage the depths of stone courses. Both bottom and top courses were spread 1 in. higher than the required rolled depth.

Special Methods of Building Waterbound Macadam

The successive sections in Fig. 2 on this page show the steps taken in the construction of the road.

The bottom course was rolled five times with a 12-ton roller before placing the screenings. The screenings were placed in piles and spread by the shovelful. The best results were obtained by going over the layer of stone several times and rolling while the spreading of the screenings was in progress. In damp weather the screenings stuck in the upper voids of the layer of stone and had to be coaxed into the lower voids. When bone dry the screenings were quickly rolled into place. The wetting was done after the screenings were all in place, about five trips of a sprinkling wagon being required.

After the lower course had been filled with screenings, wetted and rolled, the surface was broomed off, leaving the edges of the stones projecting about 1/4 in., to "lock" the top course to the lower one. The bottom course looked like a finished waterbound macadam road prior to brooming off the surface screenings. At all times when spreading the screenings, wire and fiber push brooms were kept at hand, and they proved helpful in working the screenings into the voids.

The top course of 1½-in. stone was similarly treated. About 10 trips of the roller were required per strip of pavement. The rolled strips did not exceed 300 ft. in length. (An experienced roller man is an important factor.) On the top course the screenings were spread thinly, rolled, watered and rolled again, repeating the operation several times until the desired result was obtained. The final watering showed that the result was satisfactory when water scarcely penetrated at all, but ran off to the gutters. On completion of the operation about 1/8 to 1/4 in. of screenings remained on the surface of the road.

Applying the Bituminous Mat

Before applying the tar (Tarvia B) all dust and surplus screenings were swept off the surface. Wire brooms were used to loosen the caked or crusted material, followed by fiber brooms, which left about 1/8 in. of the stones projecting. The necessity of having 1½-in. stones became apparent during this operation, for stones of smaller size were broken loose. In one place where undersized stone was used, it was necessary to put on fresh screenings, roll, water and roll again, and then rebroom the entire area before the stones would "stay put." It was necessary to keep the teams off the road after it had been prepared for the Tarvia. While brooming, ridges or fences of dust were formed along the edges of the gutters to prevent any surplus Tarvia reaching them.

The Tarvia was applied by the manufacturer, the Barrett Manufacturing Co., with a 1200-gal. Packard motor truck. The truck distributor was equipped with an 8-ft. spraying device that applied the material under 20-lb. pressure. Four trips covered a 30-ft. width of road. The penetration was from ½ to 1 in. into the surface of the road. The Tarvia was applied only when the road was perfectly dry. It required about three-quarters of an hour to empty a 1200-gal. truck. The amount distributed was about 0.54 gal. per sq.yd. In another season or so, 1/4 to 1/3 gal. more will be required.

A sufficient area of surface should be prepared to use up the whole 1200-gal. truck load, for once the distributor has started spraying, the operation should not cease until that particular "ribbon-like" paint coat is completed; stops cause an excess of tar at some point, which is undesirable.

In mild, sunny weather the Tarvia was allowed to penetrate for 24 hr., but in cold, damp weather it required about twice as long. To protect concrete curbs and other roadside structures from tar splashes, two men walked alongside the motor-truck distributor holding a shield of tar paper over all that part of the work which was to be protected.

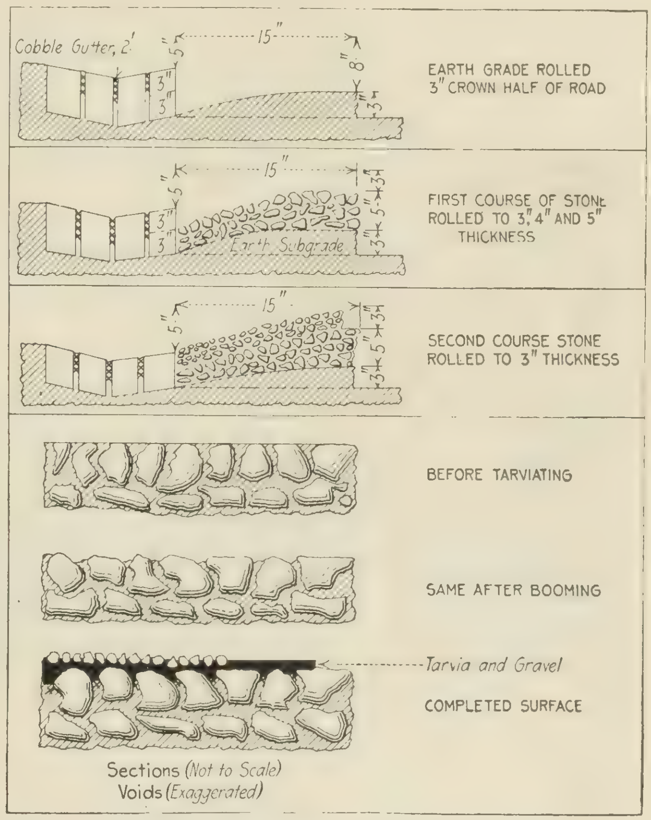


FIG. 2. CROSS-SECTIONS SHOWING CONSTRUCTION OF BAYONNE PARK ROAD

Clean, washed, pea gravel, free from sand, the gravel particles measuring 1/16 to 1/4 in. in size, was used to cover the tar coating. This was spread from piles alongside the road, 1 cu.yd. covering 100 sq.yd. of surface. Wooden garden rakes were used to spread the gravel and to remove any large-size stones. It required 14 men 8 hr. to spread 4800 sq.yd. After applying the gravel the surface was twice rolled, and the dust ridges at the gutters were removed.

Cost Data

Exclusive of grading, gutters, bridges and drains, the following is an itemized cost analysis: Stone, 38.51c. per sq.yd.; screenings, 12.2c. per sq.yd.; pea gravel, 2c.; Tarvia B, 4.59c.; teams, 1.6c.; rolling, 10.3c.; labor, 30.8c.; total, $1 per sq.yd.

Under more favorable market and labor conditions, it is estimated that the pavement could have been laid for 75c. per sq.yd.

Legal Obstacles to Street Widening and City Planning

By Charles K. Mohler*

Perhaps the greatest need in laying out and building cities is unselfish and constructive forethought to discover and provide for future requirements. How little of this has been exercised by the city and suburban subdivider is evidenced on every hand in nearly every American city.

One of the most common changes necessary to meet new and changing conditions is the widening of streets.[1] With the very best legal equipment possible to provide, street widening is a difficult, slow and expensive undertaking. Such being the case, it is of very great importance to have all the legal obstacles removed so far as possible and at the same time provide the fullest measure of legislation for undertaking constructive work. Every city should possess and use the right to establish new street lines for opening or widening, ahead of the time at which the improvement is to be carried out, and to place the necessary restrictions on the use and occupancy thereafter, between the old and new lines. When it is definitely known that changes and growth of a city will require in the future the opening of a new thoroughfare or the widening of an old one no time should be lost in establishing the new lines so as to prevent the erection of new and costly buildings on the area to be taken for street purposes. To illustrate, suppose it is reasonably certain a given street will have to be widened in 10 years. Let one property holder be ready to erect an expensive permanent building at once. Unless new lines are established, he can build out to the old lines without any restrictions and is justly entitled to damages when the improvement is made and the front of the building is torn away. With new lines established, however, any building erected beyond the new limits thereafter would have to be removed when the widening was effected, without any claim for damages. In case a property holder wished to erect at once a building to the full limit of height he could erect the main portion to the full height on the new line. Beyond this he should be allowed to erect to such height as he would deem to his interest for the time it would be allowed to stand. When the street was widened, the "encroaching" portion would have to be removed without any cost to the municipality. The building could be so designed in the first place that the removal of the portion beyond the new line would leave the main portion intact.

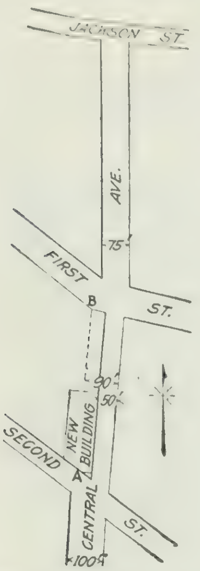


FIG. 1. STREET-WIDENING OBSTACLE

If unrestricted improvements are made but a short time before widening is undertaken, the claims for damages are of course proportionately higher. It not infrequently happens that when an opening or widening is contemplated, property holders will deliberately erect buildings on the lines of the contemplated improvement with the sole purpose of presenting claims and securing damages. The municipality should have the right to deny building permits on the affected area as soon as any official action is taken on any contemplated opening or widening.

As a concrete example of how a widening may be discouraged, if not rendered impossible, reference may be had to Figs. 1 and 2. Fig. 1 shows widths and intersections of Central Ave., a main traffic thoroughfare in an industrial district. South of 2nd St. it is 100 ft. wide; between 2nd and 1st St. it is only 50 ft.; between 1st and Jackson it widens out again to 75 ft. It terminates at Jackson. To take care of future traffic needs this street should not only be widened along the line *AB* to 80 or 90 ft., but should be carried through to the north beyond Jackson St. The area at the northwest corner of Central Ave. and 2nd St., marked "New Building," was, up to about six months ago, only occupied by cheap shacks. It is now occupied by a four-story and basement brick building, as shown by Fig. 2. Under proper control the new line *AB* could and should have been established and the necessary area reserved for widening. Under that arrangement the cost for widening in the future should not have been more than the value of the land taken, less the assessed benefits. To widen the street now, however, the value of the greater portion, if not all, of the building will have to be included in addition. This example is taken from a Pacific coast city.

FIG. 2. NEW BUILDING IN WAY OF STREET WIDENING

Looking north on Central Ave. (Fig. 1) from corner of Second St. "New building" shown on left

When the portion of a street which should be widened is faced with new and expensive buildings, it proves such a serious handicap that the widening may be put off for years, if indeed it is undertaken at all. With little or no prospect of the street being widened and extended there is little if any encouragement for a higher development along the adjoining property to meet new and better future use. If for any reason the city acquires land for street opening or widening before the work is actually carried out, the abutting property holders should be allowed the use of the land, if they desire, and be charged an adequate rental for its use.

In addition to the expense and difficulty of the municipality's actually acquiring ownership of property, there are the claims and opposition of leaseholders to be satisfied. To secure proper restrictions against claims for damages by leaseholders is another important reason for establishing new street lines well ahead of the time the improvement is actually to be carried out.

Present experience shows that the average life of most city buildings is not much over 30 years. If no alterations, repairs or new buildings are allowed without

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[1]The advantages and needs of "Acquiring Excess Land" were treated by the writer in "Engineering News," July 6, 1916.

keeping back to the new lines, the widening will be accomplished gradually and almost automatically. If on the other hand the widening cannot wait the full length of time for automatic adjustment, then damages would need to be awarded for useful buildings that were erected before the new lines were established and that had to be destroyed. This method has been successfully used in Paris and Hamburg.

It is believed that in the United States the right to establish new street lines in the way outlined, is possessed only by the municipalities of the State of Pennsylvania. It has been employed to widen at least three streets in the business district of Philadelphia, Chestnut, Arch and Walnut. The first ordinance was passed in 1870, the second in 1884, and the third in 1894. The widening of these streets has been nearly accomplished now and at very little cost to the city. The right has stood the test of litigation.

It seems the common sense and logical means of meeting future growth and needs of cities for increased street capacity.

It is to be hoped that all states may take steps that will put them in the forefront with rights by which municipalities may make normal growth and development, without burdensome legal handicaps.

Earth-Dam Failure in Bohemia Due to Bad Design

Details of the earth dam across the Weisse Desse River in Bohemia, Austria, on Sept. 28, 1916, as given in a recent issue of the *Schweizerische Bauzeitung*, show that the dam was of entirely inadequate design and construction and that its failure was only to be expected. The data are quoted from a report of E. Grohmann in the Austrian journal *Die Wasserwirtschaft*.

The dam was 41½ ft. high above valley bottom, or 47½ ft. high above foundations. The crest width was 13 ft., the base width 149 ft., and the length about 800 ft. There was approximately 40,000 cu.yd. of earth in the dam. A spillway of 200-ft. length was provided.

The embankment had a water-side slope of 1 on 1½ in its upper portion, with two berms; below the second berm the slope was 1 on 2. The downstream slope was a continuous 1 on 1½ slope. These proportions are slender. Moreover, the material was not tight, according to all the evidence and the appearance of the embankment after the failure.

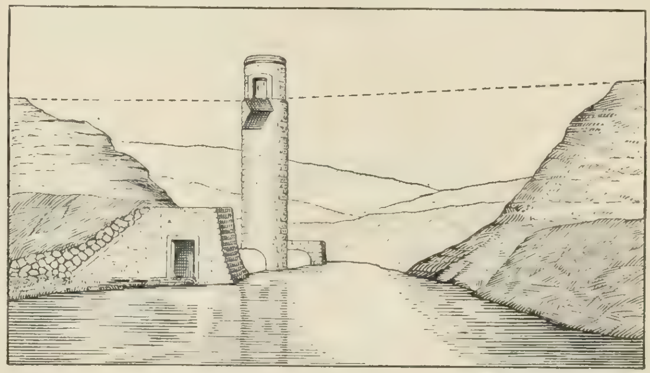
The valley soil found near the dam was used to construct the embankment. It was regarded as clay loam, and by depositing it in 16-in. layers, which were rolled by power rollers to a 12-in. thickness, a tight body was thought to be obtained. It is stated that experienced engineers before construction warned against use of the local material, which is débris of granite disintegration deposited at this particular part of the valley because the slope changes (going downstream) from 2% to 4 or 6%. According to Mr. Grohmann, the borrow pits show that the material is entirely unsuited for dam construction, though excellent for plain fill work such as a railroad embankment. The material is described as gritty and easily affected by percolation.

Moreover, the deposition in layers is described as having been unsuccessful with respect to producing a consolidated body. The faces of the break show the original 12- to 16-in. layers very distinctly. Consolidation by the roller did not extend down more than 4 or 5 in. in each layer.

The dam had a clay cutoff and water-side facing. However, examination of the faces of the break did not show any material difference between the body of the dam and the facing layers. The cutoff was carried down 15 ft. or more below ground, was about 10 ft. thick, and had a sheetpile wall along its upstream side. The clay layer was continued up the water slope to the crest of the embankment, with a thickness of about 3 ft. at the top. A 12-in. stone pavement on 16 in. of broken stone protected it against wave wash.

The outlet conduit through the dam was supposed to have cutoff walls under it extending 10 ft. or so into the ground below and backfilled with puddle. Both conduit and valve shaft do not show any cutoff, however, at least so far as the upper half of the conduit wall is concerned.

Failure appears to have originated through percolation of water along the outlet conduit. A small stream of clear water was seen to issue from the embankment just above the top of the conduit arch a short time before the failure, and in less than a quarter-hour it had increased to a stream of dirty water several inches through. Collapse of the dam over the conduit followed soon, and the water flowing out tore a large gap in the embankment (see sketch, made by the *Schweizerische Bauzeitung* from a halftone cut). The reservoir behind the dam was only about three-quarters full at the time the accident occurred.



THE WEISSE DESSE DAM WASHOUT
Sketched from a photograph

An interesting auxiliary item is that it is said there were various small leaks at the toe of the dam when the reservoir first was filled. To stop the leakage a low embankment was placed along the toe. This early leakage seems to point quite directly to the permeability of the dam body. An equally interesting fact is that the outlet conduit is said to have been founded on piles. Whether these piles contributed in any way to the washout has not been determined.

Mr. Grohmann does not hesitate to blame the failure upon incompetence and bad design.

A Motor Toll Road is to be built in Kansas, if the company incorporated as the Auto Traffic Co., of Fort Scott, fulfills its charter requirements. The proposed road will extend from Fort Scott to Pittsburg, 32 mi. The toll-road company proposes to conduct a freight and passenger business on its own account and to collect tolls from other motor-car owners for use of the road. The company has the same right of eminent domain that a railway has. It is incorporated under an old "post roads" act which has not been used in Kansas for more than 40 years. The capital is $50,000.

One-Span Concrete Arches on Sides Widen Two-Arch Stone Bridge

In Cuyahoga Falls, Ohio, a 56-year-old masonry bridge on the line of Portage St. across the Cuyahoga River has for some time been of insufficient width though of sufficient strength to carry the traffic. It was decided to widen the bridge and at the same time utilize the existing structure by building a reinforced-concrete bridge on each side and extending the roadway over the whole width of the three structures, making in so far as the roadway is concerned, one structure. The old bridge, however, had a pier in the middle of the river and two spans approximately 40 ft. each; the new sections were made in single spans of 95 ft., slightly unsymmetrical about the crown, which itself is not exactly in line with the center of the whole middle pier.

The details of the design are shown in Figs. 1 and 2. The parapet walls and roadway surface of the old bridge were removed so that the new roadway could span, with its crown, from curb to curb of the additions. This old roadway was 20 ft. wide and is replaced with a 38-ft. roadway and two 7-ft. 6-in. sidewalks, the full width of the street which it carries. The new arches have solid ribs

FIG. 3. OLD PORTAGE ST. BRIDGE

roadway is of brick resting on a sand bed covering the slab on the new sections and a newly built 6-in. concrete slab on the old fill.

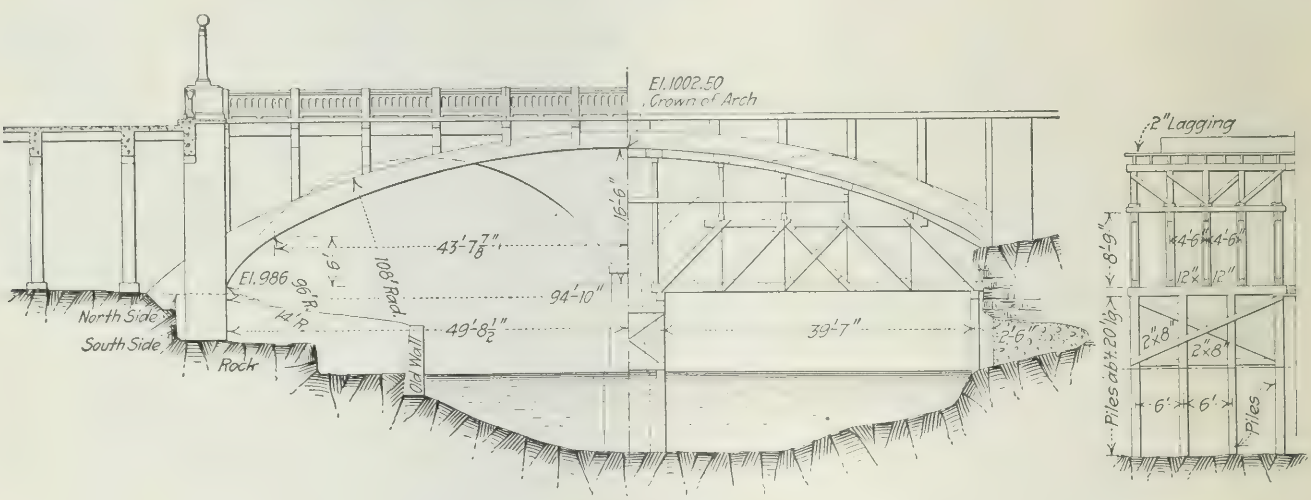


FIG. 1. ELEVATION OF PORTAGE ST. BRIDGE, CUYAHOGA FALLS, OHIO, SHOWING OLD AND NEW STRUCTURES AND FALSEWORK

carrying on crosswalls a slab floor. The ribs were built to within 1 in. of the sides of the masonry arch, a definite separation of that amount being made by 1-in. boards. The new slabs overlap the masonry arch and are also separated therefrom by a 1-in. space. The new

The most difficult problem encountered was that of building the falsework to support the masonry. The new concrete arch ring is about 25 ft. above the mean water level. Four timber bents, one on each side of the stream, and two near the center pier were built. These bents

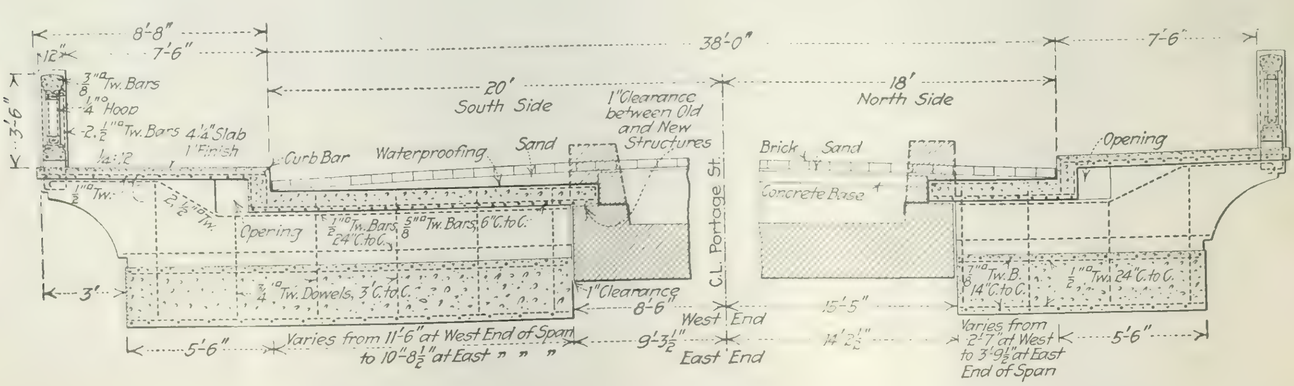


FIG. 2. CROSS-SECTION, SHOWING METHOD OF WIDENING BRIDGE AT CUYAHOGA FALLS

were used to support a series of trusses so constructed that, after being used to support the arch ring on one side of the old bridge, they were used again to support the ring on the other side. Each bent extends the full length of the old and the new work.

Posts used near the center of the stream were placed whenever the depth of the water, which depended largely on the operation of a dam above, would permit.

Ten trusses, in two units of five each, were built up of wooden planks and securely bolted together. The overall length of these trusses was a few inches less than the clear span of the old masonry. Above the trusses additional falsework was built up to support the deck that carried the concrete arch ring. When one side had been poured and the concrete set, the centers were struck and the additional falsework removed. The trusses were

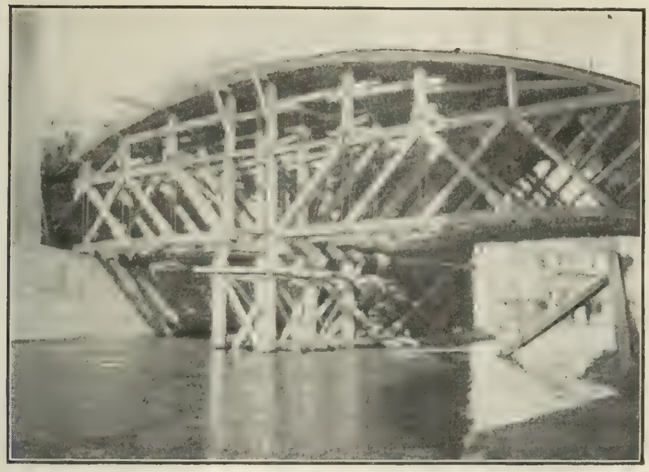


FIG. 4. FALSEWORK IN POSITION

then slid along on the bents under the old bridge, and the operation was repeated on the other side.

The work is being done for Summit County under the supervision of Edward Paul, County Engineer, Akron, Ohio, and Wilbur J. Watson & Co., Consulting Engineers, Cleveland, Ohio, by The Cavanagh-Linn Co., General Contractors, of Cleveland.

Annual Meeting of the American Society of Civil Engineers

The sixty-fourth annual meeting of the American Society of Civil Engineers, Jan. 17-18, will be chiefly notable as the first held in the United Engineering Society Building, soon to house all four of the great national engineering societies. The main floor of the auditorium, which seats about 800, was filled to overflowing. The first on the program was Charles F. Rand, President of the United Engineering Society, who made an appropriate address welcoming the civil engineers into the fold.

The final reports of three special committees were read and accepted—those on concrete and reinforced concrete, on the valuation of public utilities, and that appointed to investigate conditions of employment and the compensation of civil engineers. Progress reports were submitted by the committees on engineering education, on steel columns and struts, on road construction, on stresses in railway track, and that to codify present practice on the bearing power of soils for foundations.

The report on concrete and reinforced concrete included an explanation of the alleged shortcomings of the committee. This was kindly received, and the work of the committee was given praise. E. W. Stern, New York City, moved to have a new committee appointed to continue the work, and the meeting voted to refer this suggestion to the Board of Direction for consideration. The report on the valuation of public utilities received high praise. A meeting will be held later to receive discussion on this report.

The report on the conditions of employment and compensation of civil engineers aroused the most interest of any of the committee reports. The opinions expressed from the floor seemed to be that the average salary of $4140 for members of the society was an optimistic estimate. The motion to establish an employment bureau was again brought before the society in a letter of P. M. Churchill, and the suggestion received the indorsement of Gen. William H. Bixby, and E. W. Stern. The idea appeared to make a favorable impression on the majority of those present. This motion and also one to have a special committee appointed to investigate opportunities for American engineers in foreign lands were referred to the Board of Direction for consideration.

The progress report of the committee on engineering education was chiefly an address by Dr. Charles R. Mann, of the Carnegie Foundation, in which he stated that the Foundation's report would be ready for distribution in the course of a few months. He further stated that a second questionnaire (as to the qualities that promoted success in an engineering career) had confirmed 94 to 6 an earlier statement that improvement in mentality (honesty, tact, resourcefulness, energy, self-esteem, etc.) was more important than better technical training He believed that two keys to best mental development were what pedagogs called "motivation" and "interrelation." In practicing engineers these were typically manifested respectively by "interest in work" and "common sense." The study of American technical schools showed him that they needed to arouse more the maximum interest of students in their school work, and to secure a much greater coöperation between now separate collegiate departments, such as physics, mathematics, languages, engineeirng, etc.

The progress report on stresses in railway track told of tests conducted on the Illinois Central R.R., near Champaign, Ill., and on the Delaware, Lackawanna & Western, R.R., near Dover, N. J. Laboratory tests of the distribution of loads on various kinds of ballast are also being conducted at the University of Illinois. During the year contributions totaling $7500 were received from the Bethlehem, Cambria, and Lackawanna Steel companies, for the work of the committees on steel columns and struts and on stresses in railway track. The society expended $4115.07 on the work of the various special committees.

The award of the Norman Medal was announced to J. A. L. Waddell for his paper "The Possibilities in Bridge Construction by the Use of High-Alloy Steels." The J. James R. Croes Medal was awarded to C. E. Smith for his paper, "History of Little Rock Junction Railway Bridge." The Thomas Fitch Rowland prize was awarded to E. L. Sayers and A. C. Polk for their paper, "The Lock 12 Development of the Alabama Power Co., Coosa River, Alabama." The James Lowrie prize was awarded

to William G. Grove and Henry Taylor for their paper. "Reconstruction of the Norfolk & Western Ry. Bridge over the Ohio River at Kenova, W. Va." The Collingwood prize for juniors was awarded to Harold Perrine and George E. Strehan, for their paper "Cinder Concrete Floor Construction Between Steel Beams."

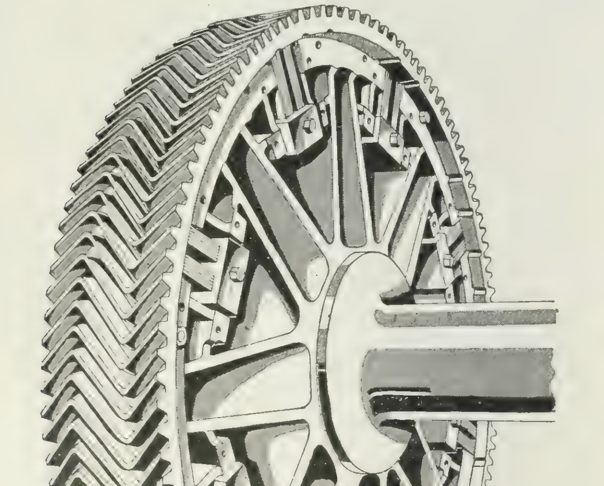
The new members of the nominating committee, to select candidates for office in 1918 are: R. S. Buck, New York City; D. B. LaDu, Albany, N. Y.; J. S. Conway, Washington, D. C.; A. J. Himes, Cleveland, Ohio; A. O. Ridgway, Denver, Colo.; L. C. Hill, Los Angeles, Calif.; W. C. Hammett, San Francisco, Calif.

The officers elected for 1917 are: President, George H. Pegram, Chief Engineer of the Interborough Rapid Transit Co., New York City; Vice-Presidents, George W. Kittredge, Chief Engineer, New York Central Lines, New York City, and George S. Webster, Director of the Department of Docks, Wharves and Ferries, Philadelphia, Penn.; Treasurer, George W. Tillson, Consulting Engineer of the Borough of Brooklyn, New York City; Directors, Alfred D. Flinn, New York City; L. D. Rights, New York City; W. R. Hill, Albany, N. Y.; Arthur P. Davis, Washington, D. C.; W. L. Darling, St Paul, Minn., and R. H. Thomson, Seattle, Wash.

A report of the discussion on road materials and construction appears elsewhere in this issue.

Large Spring-Cushioned Gear for Electric Locomotive

Marked improvement in smoothness of operation and low maintenance cost was secured in the case of the geared single-phase locomotives of the Lötschberg Ry. (Switzerland) by removing the rigid gears and putting in their place spring-cushioned gears. One of these is illustrated herewith, from the *Schweizerische Bauzeitung* of Sept. 30, 1916, where Prof. W. Kummer, of Zürich, describes the results.



SPRING-CUSHIONED GEAR FOR ELECTRIC LOCOMOTIVES

The railway has 14 locomotives, of which the 13 here in question have five coupled driving axles and leading and trailing axles. There are two 1,500-hp. motors, each gearing down a layshaft; the two layshafts drive the middle driving axle by a triangular driving bar on each side.

Serious operating troubles developed in certain of these engines late in 1915, within a short time after the line was opened to traffic. Mechanical surges between the motors and the driving axles appeared at certain speeds. Within the speed range 38 to 42 km. per hr. these surges produced a pounding sufficient to loosen the layshaft crankpins. Examination showed that the trouble was due to slight irregularities of motion, owing to unavoidable imperfections of workmanship, which caused a hunting effect involving the inertia of the moving parts and the elasticity of the system. It was concluded that the trouble would be cured if the system could be made less rigid. The spring-cushioned gear was tried for this purpose, being applied first to one layshaft of the most troublesome locomotive.

The oscillations or surges disappeared completely; thereupon a similar gear was applied to each of the other refractory engines, with the same success. Experience soon showed that important advantages were gained in reduced wear of the shaft bearings. In the case of the layshafts the wear of the bearings was reduced to one-eighth; an equally distinct gain was made in the maintenance of other parts of the drive. As soon as this fact became evident, the spring gear was applied also to those locomotives in which no trouble from surging or pound had occurred.

Up to now these locomotives have averaged 135,000 km. each, and the wear of the gears is small.

Construction and Maintenance of Catchbasins and Inlets

Quite a treatise on catchbasin construction and maintenance is the report of the discussion at the November meeting of the sanitary section of the Boston Society of Civil Engineers, printed in full in the January issue of the "Journal" of the society. Various types of catchbasins are described, and experience and cost data in cleaning them are given. Frank A. Marston, secretary of the sanitary section, summarizes the discussion as follows:

1. Where combined sewers or drains are laid on very flat grades, not providing self-cleansing velocities, catchbasins are useful to catch detritus in order that it may be removed more economically than from the sewers or drains.

2. A considerable saving in the cost of cleaning catchbasins can be effected by the use of a suitable motor-truck equipment.

3. Of the two examples of motor-truck apparatus described, that developed by George A. Carpenter, city engineer of Pawtucket, R. I., appears to meet the conditions in New England cities where the Otterson machine failed, although successful in the West.

4. Where self-cleansing velocities can be obtained in the drainage system, from the surface connections through to the point of discharge, inlets without traps should be built in preference to catchbasins, both for economy and better service. It may be more economical to construct a single catchbasin in the main drain at the head of a section laid on a very flat grade rather than to build catchbasins for a large number of surface connections.

5. Oil should be applied to the water in catchbasins, to prevent the breeding of mosquitoes.

6. Catchbasins should be regularly inspected and should be cleaned after each severe storm if necessary.

7. Catchbasins should be built only where necessary, because of special conditions, and not as a matter of custom, as appears to be the practice in some cities.

8. Unless catchbasins are actually catching grit which would otherwise be deposited in the sewer or drain, they should be replaced by inlets.

The motor-truck equipment used at Pawtucket by Mr. Carpenter is a Standard chassis with a 32-hp. engine. The steel body made by the Monahan Vehicle Co., Providence, R. I., holds 3.4 cu.yd. The dump body of the truck is provided with a hydraulic lift, operated by the transmission system of the engine. Back of the driver is a small crane carrying an orange-peel bucket, which is controlled and operated by oil or air pressure. The capacity of this outfit is 9 to 12 loads, or 23.4 to 31.2 cu.yd. per day. The average cost of cleaning basins by this method was 75c. per cu.yd., which was one of the lowest figures cited.

The Otterson machine referred to above is known as the Auto Eductor and consists of a centrifugal pump, sand eductor and dump body mounted on a Kelly-Springfield motor truck. The dump body has two chambers, one for settling the solids and the other to serve as a supply chamber for the pump. The eductor is a patented device consisting of an orifice and throat, as in sand ejectors. It is claimed that the catchbasins in Portland, Ore., have been cleaned in this manner for 60c. per cu.yd.

Adapting Motor Trucks to Desert Work

Second-Prize Motor-Truck Maintenance Article in the "Engineering News" Prize Contest

By Edwin H. Warner*

The author's personal experience, covering 20 months, with truck operation over country roads in Kern River Valley, Kern County, California, permits him to offer several comments that may be of service in spreading knowledge about certain features of design, equipment and operation which decidedly affect the success and economy of motor haulage, especially under difficult desert conditions.

The truck design of today varies little from that of the ordinary car, except in a somewhat heavier chassis and wheels. It is designed for moderate grades and smooth streets; if only moderately successful under other conditions, that fact is a matter of congratulation and not a reproach.

The road conditions in the Kern River Valley are: A rise of 2600 ft. from the railroad station at Inyokern to Walker's Pass. The grades are moderate with short sharp pitches for the first 8 mi. On the remaining 8 mi. the grade and sharpness of the pitches as well as their length increase. From the Pass the road drops 2000 ft. in 8 mi. and is followed by 20 mi. of water grade along the river bottom; then up the North Fork of the river for 12 mi. over a somewhat rolling country. As a whole the road is largely in sand, with occasional soft spots, for the total distance of 58 mi. The character of the road is such as obtains in country districts remote from the railroad—unworked except as the small tax (paid in money and labor) permits.

The temperature varies between 30° and 116° F.

The highest-priced two-ton truck on the market was used, but changes were necessary and were made along the following lines:

The gear ratio was such that too much low-gear work was called for; many of the pitches in the first 16 mi. were a shade too steep for the intermediate; this gear ratio was changed and a reduction in running time resulted. In spite of the change, there was considerable loss of time due to the heating of the engine; a 5-ft. section of 8-in. pipe was placed on the running board, connected up with the circulating water, and the trouble was remedied.

The carburetor used was all that a self-respecting carburetor should be on a $6000 family car, but was unreliable under conditions of low speed, dust and dirt. This was changed for one costing less money, but better adapted to the work.

The high summer temperature caused trouble with the lubrication; this was met by varying the oil with the season. The gasoline supply was inadequate for a round trip and was supplemented by heavy cans on the running board.

The double tires on the rear wheels cut badly in the groove between them, and were generally unsatisfactory, for they would straddle the track of the front wheel and break a track for themselves in the yielding sand. They were replaced with single tires, and the result was satisfactory.

The author's recommendations for desert service are:

1. Study the grades and road conditions and select a gear ratio that will reduce the low-gear work to 10% or less of the distance run.
2. Add at least 100% to the radiator capacity.
3. Select a carburetor whose best performance is at speeds not exceeding 15 mi.
4. Under high atmospheric temperatures watch your lubrication closely and vary the oil according to the season.
5. Increase your gasoline supply so as to cover the round trip from the railroad point; if additional gasoline is carried in cans, have them specially made of No. 14-gage galvanized iron with outside patches on the corners; strap cans tightly to running board.
6. Strengthen the running-board hangers by 100%.
7. Truss the chassis with two 1-in. diagonal rods to avoid weaving of frame, especially under conditions of a rear overhung load.
8. Avoid double tires on the rear wheels.
9. Provide a governor, limiting the speed to 12 mi. per hr., so attached that the driver cannot readily disconnect it.
10. Provide the driver with a well-upholstered comfortable seat and furnish curtains on the cab as a protection against inclement weather.
11. Arrange a speed schedule and insist upon its maintenance, thereby reducing to a minimum the driver's sociable desire to talk with acquaintances along the road and eliminating the 20-mi. gait he would otherwise hit to make up for lost time.

*Title Insurance Building, Los Angeles, Calif.

The Miami Valley Flood-Protection Work

III—Dam and Outlet Problems

Proportioning Large Earth Dams and Their Spillways; Design of the Great Outlet Conduits; Discharge Channels Designed to Destroy Energy of Discharge by Standing Wave; Details of Design Developed by Experiments

Earth dams are to be used for protecting the Miami Valley against future floods. Because these dams must be safe under all conditions, a century from now as well as when just completed, their design was studied with unusual care. The engineers aimed at ample safety of the structures, and definite knowledge with respect to all conditions of service and operation. This is best shown by the adopted dam section, Fig. 2, and by the elaborate course of large-scale experimenting through which the discharge channels were developed.

These dams will be located above large cities, and their failure would result in enormous damage. They will stand dry for years at a time and then may suddenly be subjected to full head of water, a condition which in itself raised question on the part of some residents of the valley. They must not only be safe under normal conditions, but also safe even if supervision and maintenance should become lax. They must be foolproof. Their outlet conduits must be permanently open and unblockable. The discharge of large volumes of water at high spouting velocities must be rendered powerless to do damage.

FIG. 1. EXPERIMENT STATION WHERE HYDRAULIC-JUMP TESTS WERE CARRIED OUT

The greatest of these problems, perhaps, was that of the discharge conduits, which under maximum conditions will deliver the water at a flow-velocity of nearly 60 ft. per sec. The Taylorsville dam, which has the largest conduits, is designed for a discharge of 55,000 cu.ft. per sec., nearly as much as the present safe flood-flow capacity of the 600-ft. channel of the Great Miami at Dayton. The power residing in this discharge must largely be dissipated before the water can safely be delivered to the river channel below. Even within the conduits the destructive ability of the high-velocity flow is so great that local defects in the structure of the conduits might lead to destruction.

Protection of the conduit entrances from obstruction by drift carried down in floods also called for attention. The engineers did not look on drift as a serious source of trouble, but the fact that residents of the valley had strong fears in this regard made it desirable to provide efficient protection.

Design of the Dams

Satisfactory dam sites were located for the construction of earth dams. Thorough exploration by borings was undertaken in order to find rock foundations for the outlets and spillways. This search succeeded, although one of the dams had to be shifted from the preliminary location to get the desired rock foundation for the spillway at suitable depth. The rock foundation at all the dam sites, except Lockington, is geologically known as the Cincinnatian formation and consists of layers of hard limestone interstratified with shale or hard clay. Investigations have satisfied the engineers that this formation will provide a foundation well suited for the outlet works and spillways. At the Lockington dam site the ledge rock is Cedarville limestone, a comparatively hard rock of massive bedding. At those dams which have spillways outside the dam structure itself, satisfactory rock channels for the spillways were found. The dams themselves in all five cases will be built on earth bottom. This condition and the nature of the materials available near-by dictated earth-embankment construction. Basin capacities were fixed by the spillway levels chosen. Generally, these were governed by natural limits of elevation—the adjoining ridge elevations or the location of towns that could not be flooded (as at Taylorsville) or the limits imposed by economy in railway readjustments (as at Huffman). At Englewood the economical and desirable capacity of the reservoir, rather than the height of dam, was the limiting consideration.

Since a large spillway-flow depth was desired—for safety margin above all flood forecasts—the heights above spillway crest were worked out on a uniform basis. To this end an imaginary flood runoff of 14 in. in three days, which is no less than twice as large as that of 1913, was assumed; with spillway lengths determined by other considerations, the overflow depth was computed (the conduit discharge continuing at the same time). This gave depths ranging from 10 ft. at some of the dams to 14 ft. at others. A uniform freeboard of 5 ft. above this imaginary water level was then adopted, which fixed the dam-crest elevations.

With respect to the proportioning and methods of construction of the dams, the existence of some popular prejudices against dams—and especially against earth dams—was held to justify excessive safety provision.

The fears were concerned partly with the fact that the dams would be dry for years and then might suddenly be exposed to full service, with maximum head of water stored in the basins, for periods of one to three weeks (the Englewood basin, which has the highest dam and for its storage the smallest conduits, will take three weeks to empty after the assumed maximum flood). Although there was virtually no direct experience on this subject that could be quoted, the engineers were at all times convinced that the dry dams would be *far safer* than dams that are constantly wet and exposed to percolation under head.

The soil in the valley and on the adjacent upland is glacial till, comprising gravel, sand and clay in varying proportions. Prospecting and sampling proved that tight mixtures were either naturally available or could be put together. This fact was verified carefully, by analyses of grain size and by the expert judgment of men long engaged in earth-dam construction. It simplified the questions of foundation and of dam design quite materially.

No Core Wall or Lining; Cutoff Trench Used

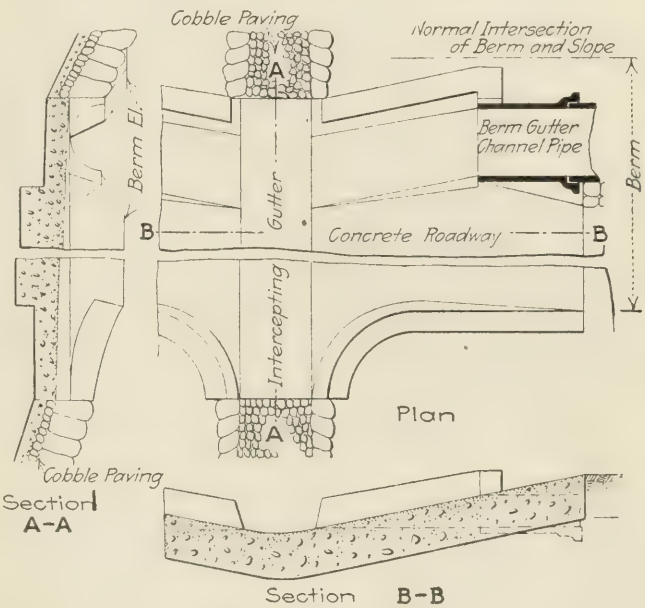
Construction of an embankment by either roller compacting (in layers) or by hydraulic deposition was decided to meet all requirements, without lining or core wall. A cutoff trench to go down 30 ft. or so, well below the surface layers, will be used.

The section adopted, Fig. 2, is distinctly more ample than that of the latest and strongest existing dams on tight or semipermeable foundations—though, of course, not comparable with the Wachusett or Gatun type. It is proportioned for specially wide base. The features are frequent berms, concaved sides and symmetrical outline—that is, upstream and downstream faces alike (because these are dry dams). Compared with the standard embankments of the Board of Water Supply of New York City, the upper berm is nearer the top and the slopes flatten out more toward the bottom, to a maximum of 4 to 1. Toe protection of broken stone sloped 10 to 1, as shown in the sketch, may be added if found convenient or desirable.

The slopes are to be grassed, top soil being placed on the structural body of the embankment for this purpose. It is intended that they shall be kept trimmed and neat at all times after construction, as part of the regular maintenance work of the district.

Slope drainage (for surface water) is accomplished by paved berm gutters and connecting gutters down the slopes. The chance of deterioration from settlement or any other cause is held to be vanishingly small with gutters, as compared with buried pipes.

The cutoff trench is indicated in Fig. 2, although local conditions will determine its depth. It is intended mainly to give most intimate connection between the impervious dam core and the subsoil, and thereby prevent seepage along the base. In all cases the dams will be built on ground stripped of top soil. The subsoil contains very little bedded porous material, so far as the borings and test pits revealed; in the process of making wash borings, the pipe lost its water only rarely. Geological indications are that any porous deposits are local—that is, have little horizontal extent. It is also important to recall that underwashing of a dam is a slow process, while here the water will never stand behind the dam more than a short time.



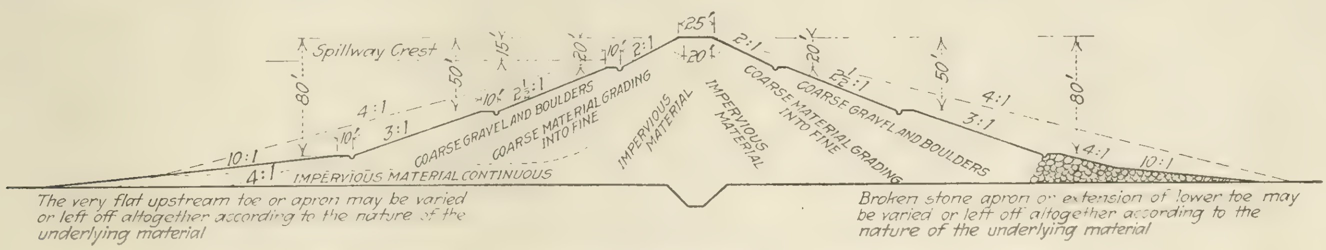


FIG. 2. TYPICAL CROSS-SECTION OF MIAMI CONSERVANCY DAMS
With detail of berm and gutter shown above

At the Huffman dam, in Mad River Valley, the most porous ground was encountered (Fig. 5). For purposes of calculation this material was assumed to be as open as very coarse sand. Yet the computed velocity of outflow proved to be almost infinitesimally small ("five times the velocity of the long hand of a watch"), although the extreme case was taken of the outflow concentrated in a 3-ft. width at the toe of the dam.

It is believed that the dam body as shown by the section, with the materials available in the valley, will be permanently sound, and proof against accidental or malicious injury as well as against deterioration.

The vital element of these dams lies in the outlet conduits. They must always be open, or the retarding basins lose some of their protective power. They must be struc-

turally sound, or the high discharge velocities might tear them to pieces and wash out the dam. Straight flow lines and smooth, durable surfaces must be obtained. The Germantown and Englewood conduits must carry the weight of 120 ft. of earth above, without cracking or deforming, even when slight settlement or shrinkage of the embankment takes place. They must be bonded tightly into the embankment, so that water cannot flow along the outside of the walls.

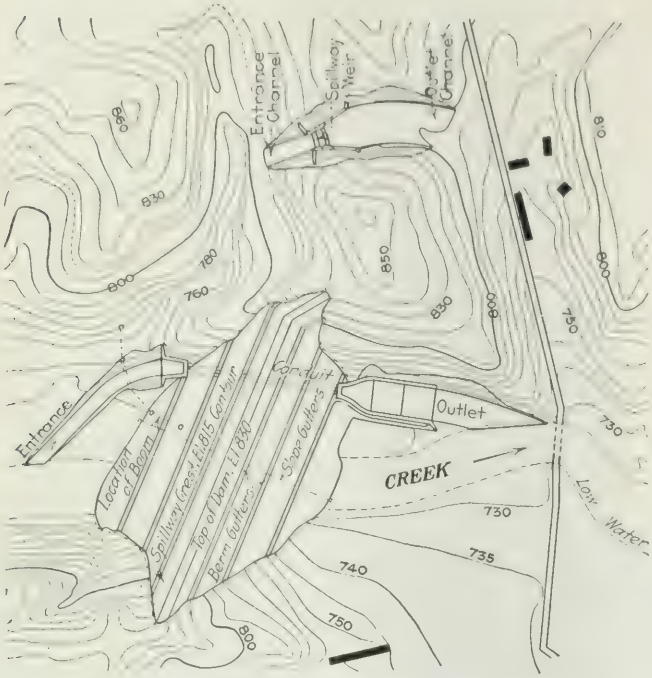


FIG. 3. PLAN OF GERMANTOWN DAM, SHOWING SEPARATE SPILLWAY

The prime importance of open outlets made it desirable to employ two (or more) conduits rather than one. If surface wear of the interior requires relining or the like, one conduit at a time can be taken in hand without endangering the operation of the system.

Separation of conduits and spillways (Fig. 3) was attempted in all cases, at first. The advantage of a spillway built in natural ground was considered decisive, while the conduits could not well be tunneled through the hillsides, but had to pass under the embankment. On further study, however, especially with regard to construction procedure, it was found that a combined outlet-and-spillway structure located within the embankment possesses marked superiority, at least for low dams. Such a structure solves the problem of stream control while the embankment is being carried up. For this reason the Taylorsville, Huffman and Lockington dams were provided with combined structures. At the two high dams, Germantown and Englewood, the separated spillway and conduits were found to be more practicable and economical.

The plans, Figs. 3 and 4, represent the two types—the separated structures of Germantown dam and the combined structure of Huffman dam. The difference of length of conduits should be noticed in Table 1, 725 ft. against 40 ft. Since the friction loss in the long conduits amounts to more than 10 ft. of head, the longer conduits must be appreciably larger—and therefore more costly—to secure the desired discharge capacity. Further, the long conduits involve more complication in the way of transverse joints, cutoffs, etc., and structurally present more difficult problems of design. On the other hand, with a combined structure the retaining walls that form the spillway abutments become enormously expensive when a height of 100 ft. is approached, as at Germantown and Englewood.

The proposed construction procedure is to build first the concrete trough formed by conduit floor and spillway abutments, leaving out the spillway and conduits. This trough forms an ample stream channel, through which the river is diverted. Construction of the dam then proceeds under safe conditions. Finally the concrete trough is bulkheaded off so that the conduit division walls can be concreted. As the last step, the spillway body is built, this work lying well above normal stream level. Deep notching of spillway into side walls will take care of downstream thrust of impounded water.

Cross-sections of the conduits are given in Figs. 6 and 7. For the combined structures, substantially rect-

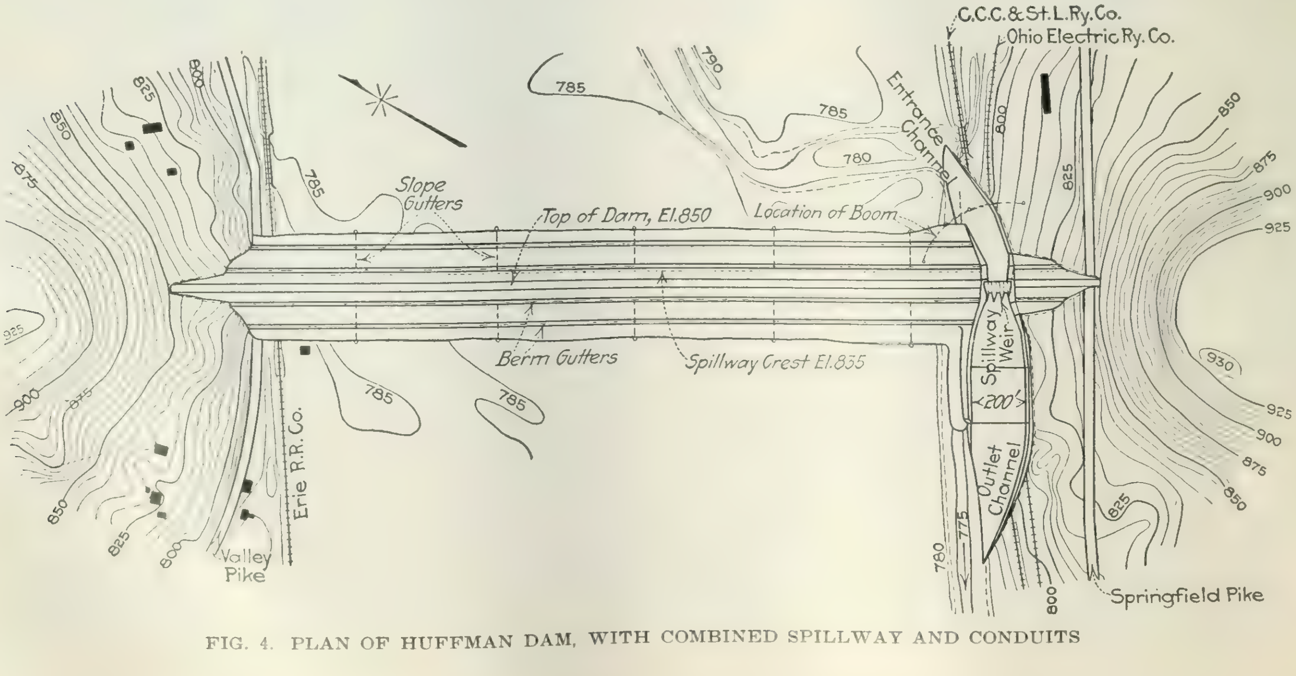


FIG. 4. PLAN OF HUFFMAN DAM, WITH COMBINED SPILLWAY AND CONDUITS

-angular sections were adopted, while the separate conduits are of horseshoe shape. A rich lining is to be used—a 1 : 1½ : 2½ concrete placed in the forms integral with the body—for resistance to abrasion. Whether hard-brick facing of the invert will be used is not decided. Table 1 shows the maximum conduit velocities in cases of great floods. These velocities are high, but not as high as in the case of several other structures where concrete conduit linings are giving perfect satisfaction. At Arrowrock dam, for instance, the concrete outlets have been subjected to velocities as high as 70 ft. per sec. for several weeks at a time during the last two years, and to velocities above 60 ft. per sec. for much longer periods, with no indication that the concrete lining will not remain in good condition indefinitely (Charles H. Paul). Many other instances are on record where carefully constructed concrete linings are withstanding velocities as high as 60 ft. per sec. with no signs of wear. And in practically all these cases the periods of high velocity are much more frequent and much longer than will be the case with these.

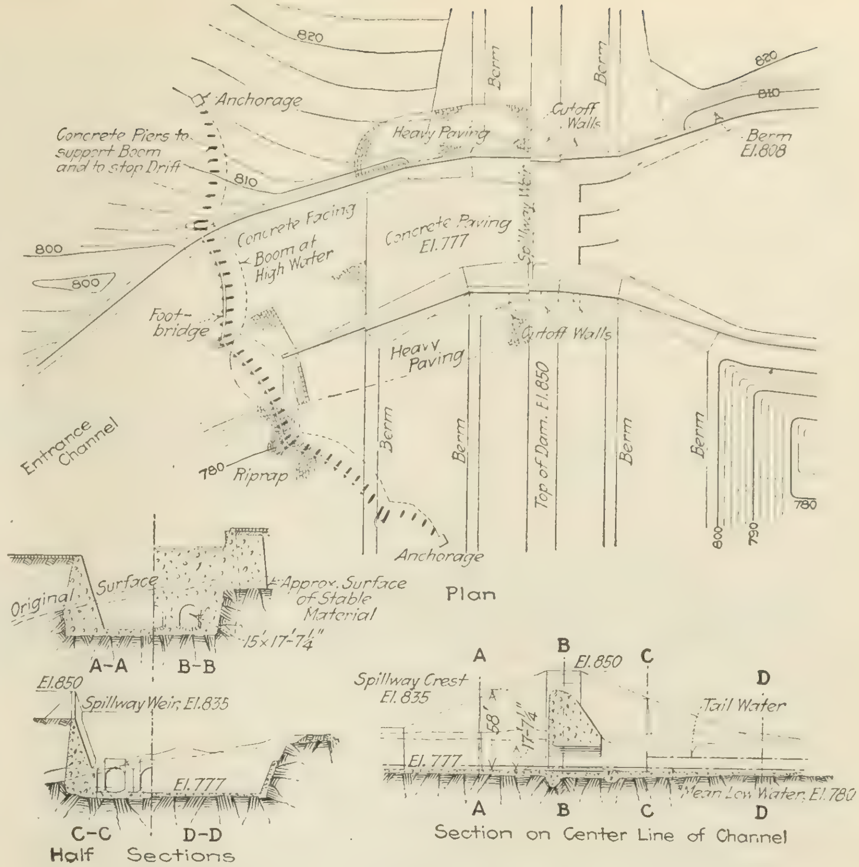


FIG. 6. COMBINED SPILLWAY-AND-OUTLET STRUCTURE OF HUFFMAN DAM

TABLE 1. DISCHARGE-CONDUIT VELOCITIES

	With Ultimate Maximum Flood, Ft. per Sec.	At 14-In. Flood, Water 5 Ft. Below Dam Crest, Ft. per Sec.	Length of Conduits, Ft.
Germantown	55	59	520
Englewood	56	60	725
Lockington	56	61	45
Taylorsville	48	57	40
Huffman	50	59	40

The entrance end of the conduits is flared or belled out slightly, to avoid throttling under full flow. Above here the entrance channel is tapered smoothly, for good approach, and beyond the concrete approach platform the earth surfaces of channel and embankment are paved with

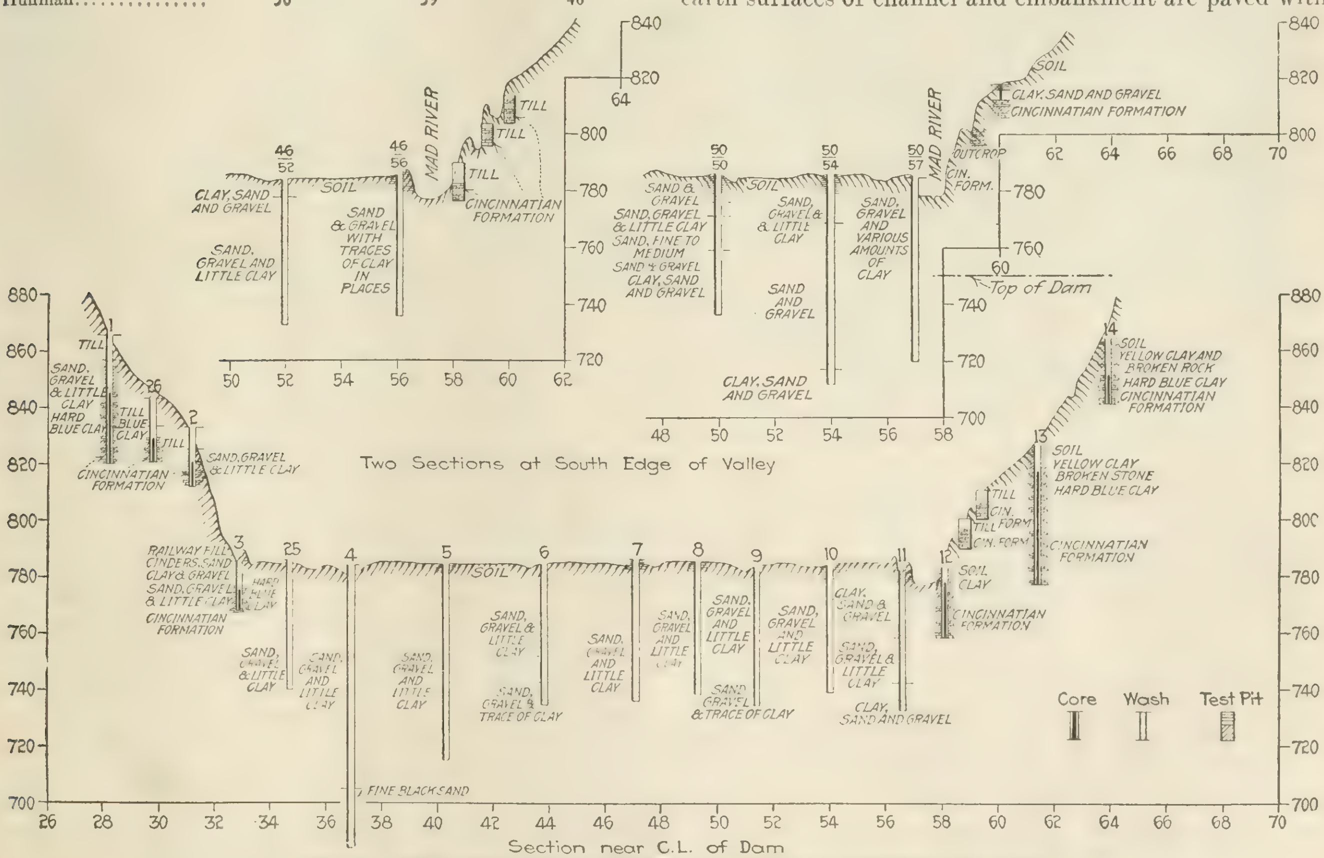


FIG. 5. SECTION OF MAD RIVER VALLEY AT HUFFMAN DAM SITE

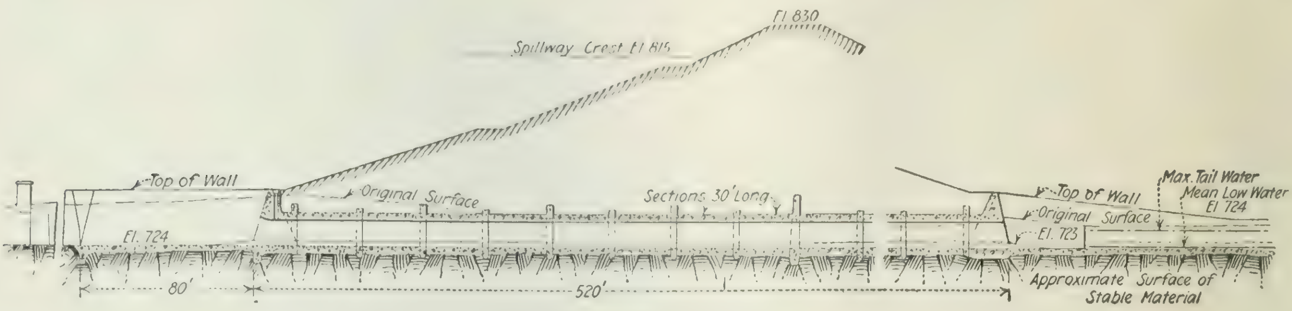
stone to prevent erosion. At the lower end, the conduits open out on a discharge channel, a remarkable structure of critical importance, whose development by experiment is noted farther on. Belling the outlet ends of the conduits was considered, but rejected.

The long conduits presented various structural problems. They carry over 100 ft. of fill at midlength and not more than 10 or 15 ft. near the ends. In some cases the rock on which they will be founded may be capable of taking only comparatively low bearing pressures with safety; and although no settlement is anticipated, it was thought advisable so to design the structure that it would accommodate itself to slight settlement, if necessary. The questions of stress distribution and arch action needed study, therefore.

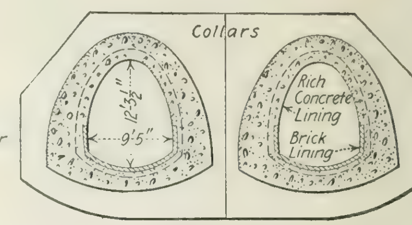
The foundation rock, the Cincinnatian formation, varies considerably in load capacity, depending on whether the clay layers are already consolidated to shale or remain of clay nature. In the latter case the allowed loading will be limited to what hard, confined clay can carry. There will be no serious difficulty in designing to this limitation. The strata all are horizontal, although the rock surface (probably formed by glacial erosion) goes down sharply from the valley sides to great depths—well over 100 ft. at most of the sites (see Huffman site section, Fig. 5).

A factor in the structural design was the desire to avoid the use of steel reinforcement above low-water level. The conduit walls and arch were therefore designed of mass section. The floor was at first planned out as a plain arch invert. With footing pressures limited to 7 tons and a load of 61 tons per lin.ft. of wall (at Englewood), the floor must distribute the wall loads of a single conduit over 18 ft. of width. To do this in reliable manner by an arch invert seemed difficult, and alternative plans for a reinforced slab floor have been prepared. The two conduits of a pair were kept structurally separate (except at the headwalls), to avoid eccentricity of loading on the foundation. Each was then analyzed as an arch, by least-work methods. The superincumbent earth was assumed to exert a vertical pressure equal to its full weight on the horizontal projection of each element, and a lateral pressure on the vertical projection equal to one-third the vertical unit pressure. Recognizing, however, that the load distribution is rather uncertain, the ratio of side pressure was varied from 0.26 as lower limit to 0.40 as upper limit, and the pressure line was kept in such a range of position that the unit stresses in the concrete would never exceed the allowed pressures by more than 20% due to change in ratio.

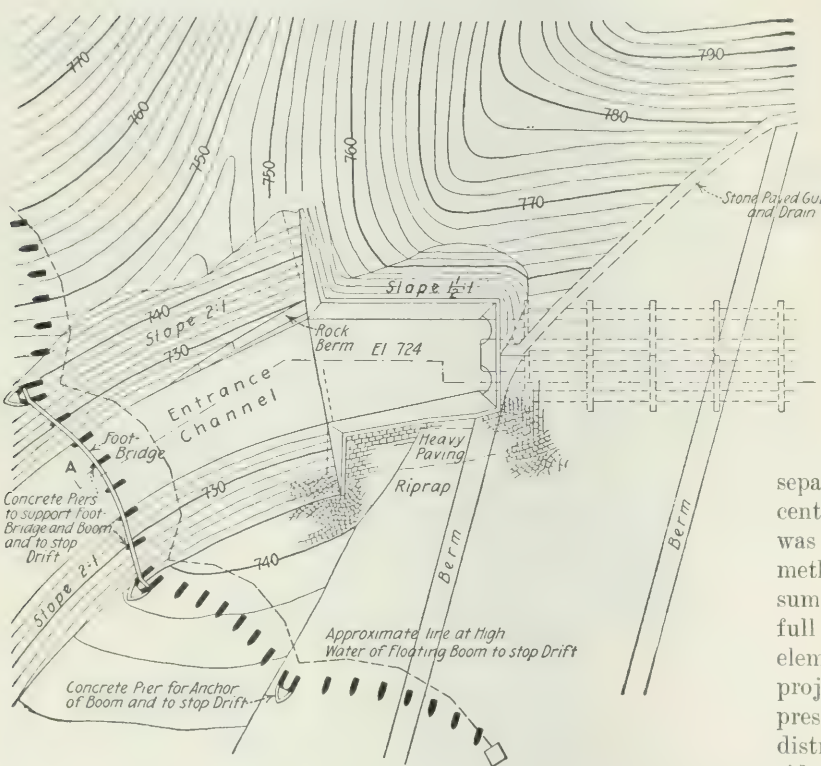
With regard to compressibility of the foundation strata and temperature stresses, the conduit arch is to be made virtually three-hinged, by placing construction joints at bottom of side walls and at crown. Interposition of a thin cushion layer—as asbestos felt—in these joints is expected to insure perfect adjustment of the arch to its load and to temperature variation. Without the three-hinged arrangement the computed temperature stresses were serious (up to 250 lb. per sq.in.).



Section A-B



Cross-Section of Conduits



Plan

FIG. 7. GERMANTOWN OUTLET CONDUITS
Plan, profile and cross-section of conduits

The structural calculations were made for two thicknesses of wall—that is, with and without the lining layer. This will insure safe stability even during a period of repair, when, for example, the lining might be cut out for replacement.

Longitudinal shrinkage is taken care of by building the conduits in 30-ft. sections. These are to be laid up concrete against concrete and are not intended to give room for expansion, as it is expected that the work will

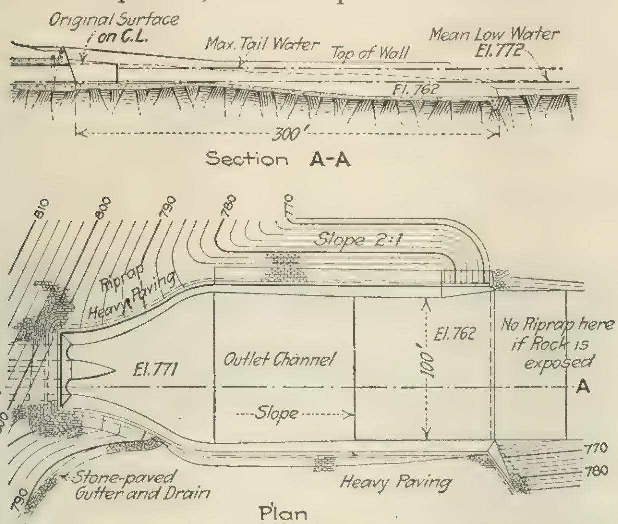


FIG. 8. ORIGINAL DESIGN OF DISCHARGE CHANNEL

be carried out in summer temperatures. Each length has a 3-ft. cutoff collar at one end, integrally formed. Larger collars (6 to 8 ft. wide radially) will be placed at the center of the dam.

The water spouting from the conduits at great velocity (see Table 1) must be brought down to not over 6 to 8 ft. per sec. before it can be discharged into a natural channel. The assumption was made that 12 ft. per sec. is a maximum for flow over riprap. Of the possible means for destroying the energy stored in the spouting water and bringing its velocity down to the limit indicated, the hydraulic jump or standing wave was chosen as best. It was known that the jump would result automatically in any event and would be fairly straight and regular if the discharge were flattened down to a thin, wide sheet. But unusual conditions had to be provided for, in the form of very high initial velocity at full head in the basin, variable velocity during filling or emptying of the basin, and concentration of the discharge in several separated jets—one from each conduit. Under these conditions there might be such irregularity in the line of the jump and such variation in its position as to require an unduly long concrete channel, which was bound to be very costly. Experiments were undertaken to develop a form of channel that would regularize and stabilize the jump, so that a short discharge channel would suffice. Two long series of experiments were made, on a linear scale of one-sixteenth and a velocity scale of one-fourth full size (one-fourth because $\frac{1}{4}v$ is proportional to $\sqrt{\frac{1}{16}h}$). They were made on the farm of E. A. Deeds, chairman of the Board of Directors of the Conservancy District. A small lake furnished convenient opportunity for water-supply and discharge. A large centrifugal pump, forcing water through two pipes about 6x9 in. each, and a wooden flume 10 ft. wide by 26 ft. long by 3 ft. deep, within which various forms of wooden discharge channel could be built up, constituted the apparatus (see Fig. 1).

The first series showed that a 10% down-slope in the channel, following a smoothly curved widening, would develop a good uniform sheet, near the foot of which the jump would occur. The discharge channel designed in the early part of 1915, shown by Fig. 8, was based on these experiments.

Jump Stabilized by Steps and Tailwater Weirs

Still greater stability and regularity seemed desirable, however, especially to avoid local high-velocity currents in part of the width at the delivery end of the channel. An elaborate set of experiments on the effect of obstructions in the channel was therefore undertaken. It was believed that such obstructions would localize the jump in reliable manner. The belief was verified by the experiments.

The two principal elements of variation tried out in these experiments were: (1) Weirs in the channel just beyond the jump, to control the level of tailwater; (2) irregularities or roughnesses in the bottom of the sloped

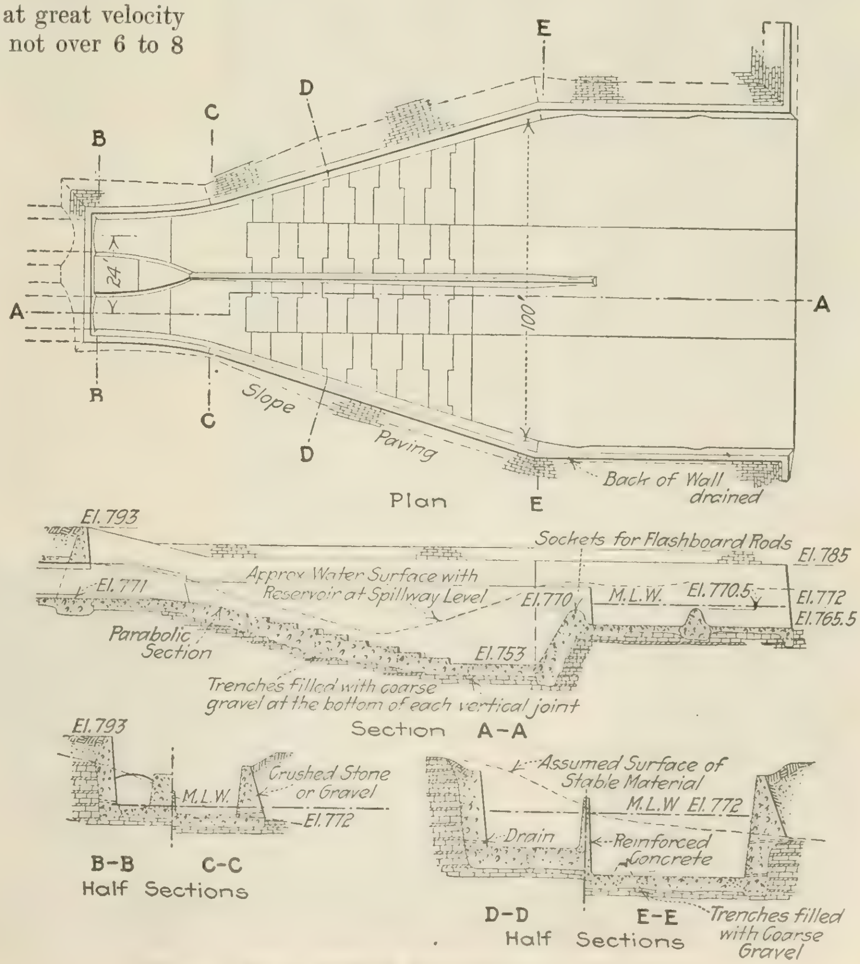


FIG. 9. FINAL DESIGN OF DISCHARGE CHANNEL

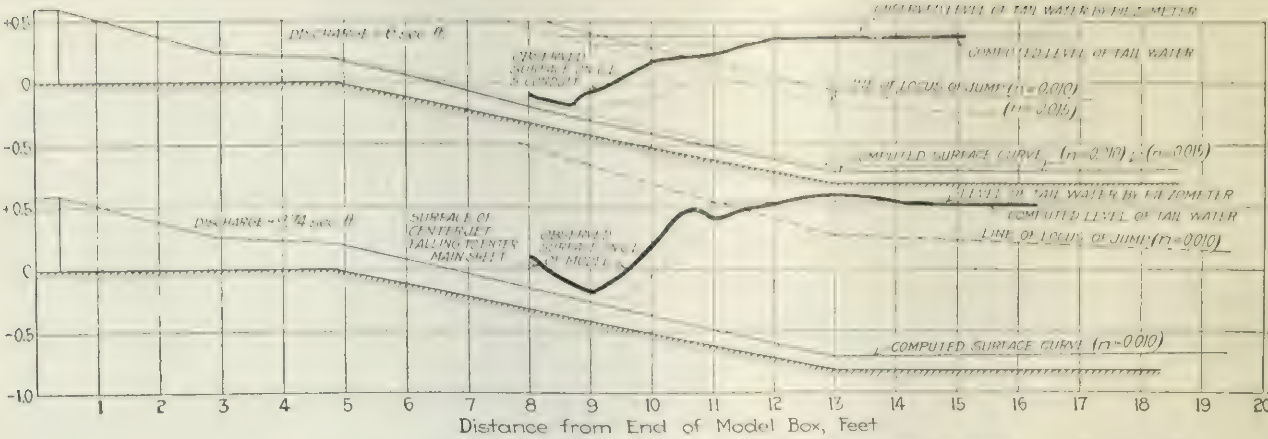


FIG. 10. PROFILE OF JUMP, FROM ONE OF THE EXPERIMENTS

channel, to produce more equal lateral distribution of velocities in the water approaching the jump; and (3) division walls to separate the several conduit jets, extending for various distances, to a maximum where the end was well beyond the jump.

It was early found that a 15% slope in the channel was better than a 10% slope. Some of the further conclusions from the experiments are as follows:

The jump begins above the computed position and ends below it, the latter point being indefinite.

When the water can be made to enter the jump in a sheet of uniform thickness and velocity across the channel, the jump is stable; that is, it is uniform across the channel, and the tailwater moves away without great excess of velocity at any point. The side wall must not be concave toward the water until the jump is passed.

A nonuniform sheet tends to produce an unstable condition of the jump, causing the flow below to be concentrated at high velocity on one side of the channel. Stability is secured by the use of one or more submerged weirs below the jump. The weirs must not be placed close enough to the jump to interfere with its normal formation.

When the flow from one conduit is materially diminished, a high weir is necessary, the most satisfactory height being about one-half the depth of the tailwater at maximum discharge. The addition of a second weir below tends to increase the stability of the jump and to improve the distribution of flow below.

The inclined portion of the channel above the jump may be shortened and steepened indefinitely, provided that the floor be not below the parabolic path of the water issuing as a jet and that sufficient length be provided to permit the water to spread so as to develop a thin and nearly uniform sheet.

Roughening the inclined portion of the channel floor with steps or other equivalent means checks the velocity by increased friction and increases the stability of the jump.

Three views of the jump as realized in the experiments are given in Figs. 11 to 13. A sketch of the profile of the jump in two cases is reproduced in Fig. 10.

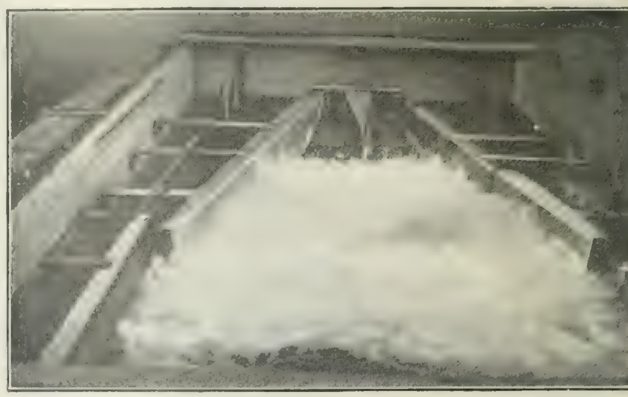
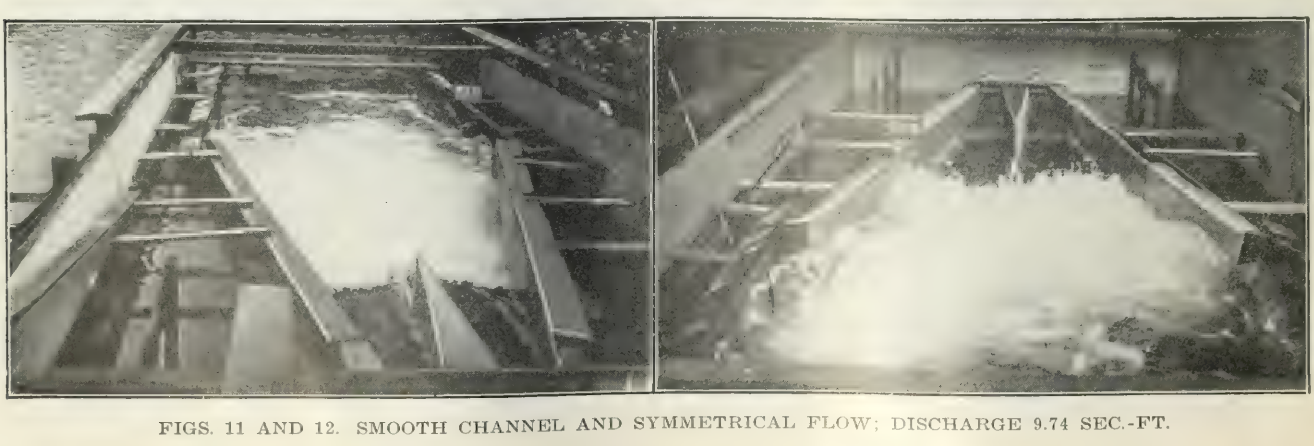


FIG. 13. JUMP WITH 6-IN. WEIR 1 FT. BELOW FOOT OF SLOPE; DISCHARGE 9.74 SEC.-FT.

These experiments furnished the basis for the complete detailed design of the discharge channel. The final result is given by the drawing, Fig. 9. It includes the stepped slope, the pair of submerged weirs and the dividing wall to a point beyond the jump.

The discharge channels will all be founded directly on rock (Cincinnatian formation), and will have a substantial thickness of concrete floor. It will be necessary to construct this floor in separate blocks, on account of its size; but care will be taken to avoid any large grooves or openings between the blocks, where the high-velocity eddies of the discharge might get a hold for destructive action.

Protecting the conduit entrances against drift was not as serious as might be supposed without an analysis of the situation. Floods large enough to pick up any drift of


FIGS. 11 AND 12. SMOOTH CHANNEL AND SYMMETRICAL FLOW; DISCHARGE 9.74 SEC.-FT.

troublesome size would quickly submerge the conduit openings. Drift that enters the basin or is picked up by the rising waters after a small pond had been formed would be moved only very slowly by the current, but its movement would be controlled largely by the wind. Even should it reach the vicinity of the conduit inlet, it would either pass straight through or float harmlessly on the surface. With the designs of inlet adopted the possibility of clogging would be exceedingly remote.

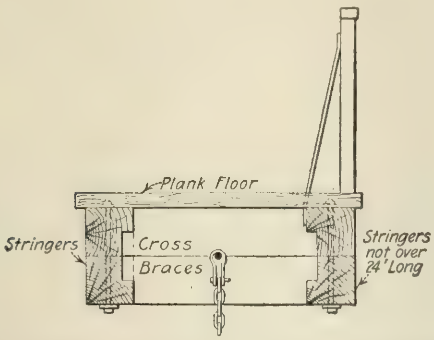


FIG. 14. SECTION OF FLOATING BOOM FOR DRIFT

Because of popular doubts on the subject, however, and also because drift barriers could be constructed at small cost, it was decided to provide further protection by a series of concrete piers spaced 10 ft. apart in the clear, rising nearly to spillway-crest level, and a floating boom. Large pieces of drift—trees, telegraph poles or even houses—would be held back by the piers. Smaller floating material would be held back by the boom.

The boom is anchored at intervals to heavy abutment piers and normally rests on top of the intermediate piers. The boom design reproduced by Fig. 14 was included in the Official Plan, but this may be improved before construction is started; it is regarded as adequate, but not necessarily the most practical form of construction.

The boom is normally about 30 ft. above top of conduits. Its channel portion hangs rather low and may be within reach of one-year or two-year floods, although these are expected to go through most of the basins without detention.

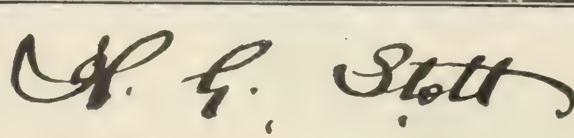
Kenneth C. Grant had charge of studies of action of retarding basins during floods and directed the preparation of practically all the tables and diagrams referred to in this article; A. B. Mayhew made numerous studies of balancing various reservoirs in a harmonious system; Barton M. Jones developed general method for determining requisite spillway capacities for any set of conditions.

H. G. Stott's Part in New York City's Rapid-Transit Development

Henry Gordon Stott, whose death on Jan. 15 was noted in *Engineering News* of Jan. 18, had a very important part in the development of New York City's rapid-transit system. This part was the supervision of the design, construction and operation of the great electric-power generating plants that energize the whole system of subway, surface and elevated railways in the greater city.

The post to which Mr. Stott was called in 1901—Superintendent of Motive Power of the Manhattan Railway Co.—had just been created; and it devolved upon him to organize the operating force, in connection with which he completed the 74th St. power plant of the company, various substations and transmission lines. When the Manhattan system was amalgamated with the Interborough in 1904, he took over supervision of the construction of the power plant on 59th St. Since that time he had been constantly in charge of design, construction and operation of the power-generating stations and the distributing system of the Interborough Rapid Transit Co. and the New York Railways Co. The plans for the electric-power system of the new subway lines have been developed under his supervision, and the work has progressed so far and bears so strongly the stamp of his work that, when completed, it will be a monument to him.

His engineering activities included most whole-hearted and conscientious service in three of the great national engineering societies, as President of the American Institute of Electrical Engineers, as a Vice-President of the American Society of Mechanical Engineers, as a Director



of the American Society of Civil Engineers and as Vice-President and Trustee of the United Engineering Society. In the American Institute of Electrical Engineers Mr. Stott was a member of the Standards Committee, the Committee on Development of Water Power, the United States National Committee of the International Electro-technical Commission, the Power-Stations Committee, the Committee on Economics of Electric Service and was on the Joint Committee on the Metric System, of which he was an ardent advocate.

Notes from Field and Office

Heavy trucks hauled out of excavation by way of two inclines—Non-calculus solution proposed for the sphere segment problem—Derricks for unloading cars—A simple hook gage

Hoisting Engine Snatches Wagons from Deep Excavation

The huge excavation for the Pennsylvania Hotel, opposite the Pennsylvania R.R. terminal on Seventh Ave., New York City, is 75% complete. The site is about 400x200 ft. in plan. The depth of excavation is 35 ft. below the street level and is principally in Manhattan schist. The yardage is 100,000. Already 40 column footings have been put in, and the excavation is going forward at the rate of 300 yd. per day. The rock is drilled and shot, loaded by hand into skips, which are lifted by derrick and dumped into elevated hoppers conveniently placed. Both teams and motor trucks haul the spoil out of the excavation and to the dump. A revolving steam shovel at the east end loads directly into trucks.

On each side of the site is one of the Long Island R.R. tunnels; the tunnel on the north side is almost entirely within the building site. The excavation has already uncovered this tunnel, the roof of which serves as a roadway for the trucks and wagons.

The spoil is hauled out by way of two inclines—one rising from subgrade to the roof of the north tunnel, the other rising from this intermediate level to the street, as shown in the accompanying sketch. The lower incline is about 70 ft. long; the other is 150 ft. An electric hoist installed under the head of each incline snatches the loads out of the pit. The wagons and trucks are moved smoothly, the delays being brief.

From the top of the shorter incline the motor truck continues to the foot of the second incline, where it stops to have two steel cables hooked to steel eyes fastened on each side of the front of the chassis. Rings have been bolted on each side of the frame toward the rear, and a rope attached to the end of a stick is threaded through each of these rings, the other end of the rope being held by men who walk up the incline behind the truck. The stick is for blocking the rear wheels in the event of the cables snapping or the hoisting power going off. Only the motor trucks are protected in this manner (Fig. 1), the wagons depending for safety upon the teamster, the handbrake and the horses.

The empties are safely retarded in going down, by a line attached to a ring at the rear of the wagon. This

FIG. 2. LOOKING WEST TOWARD LONG INCLINE FROM TUNNEL ROOF TO STREET

serves another purpose than preventing runaways, as it also returns the line to the foot of the incline, so that it may be attached to the next outgoing vehicle.

The trucks and wagons drive under one of the two elevated hoppers shown in the sketch and are loaded through a trap. After shooting, the rock is placed by hand in large skips or in dump buckets, which are lifted by the nearest derrick, and dumped into the hoppers. One of these hoppers is built on the tunnel roof. After a wagon is

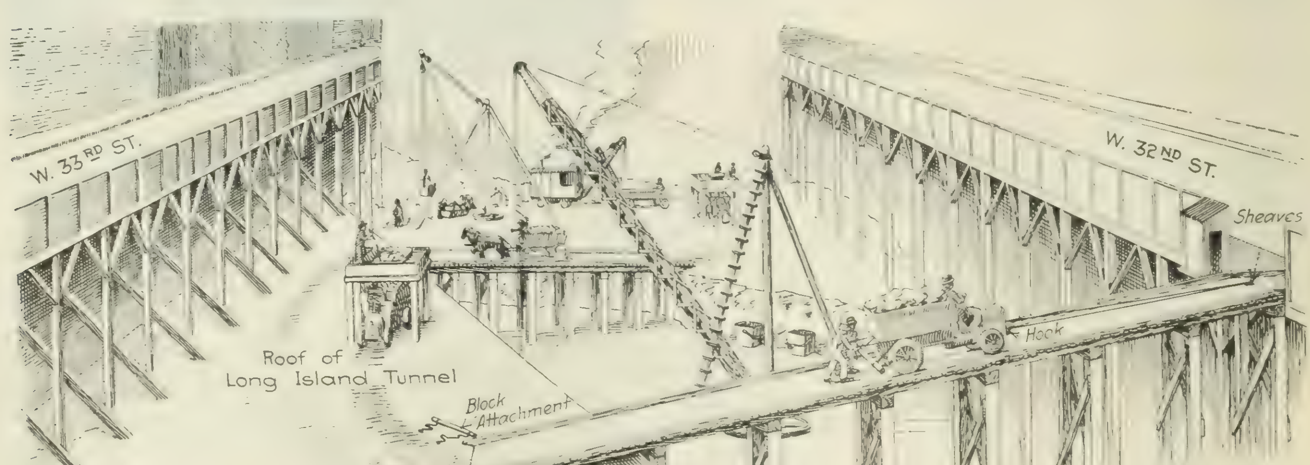


FIG. 1. HANDLING ROCK AT SITE OF PENNSYLVANIA HOTEL, NEW YORK CITY

loaded here, it is given a start by a snatch team of three horses. The trucks are able to start under their own power.

The George A. Fuller Co. is the general contractor. The hauling contractor is Jacob Fradus.

An Elementary Solution Proposed for the Sphere Segment Problem

The interesting sphere segment problem discussed by various readers in our issue of Mar. 16, 1916, p. 518, is revived by Austin K. Wardwell (Cambridge, Mass.), who proposes an exact *non-calculus* method of solution.

The problem is to find the volume of the part segment whose front half is shown heavily outlined in Fig. 2, given the radius of the sphere and the ordinates of the two bounding planes (which are at right angles). Mr. Wardwell's method of attack is to find the volume of the spherical cone swept out by a radius passed around the surface area PKL, and deduct from it the volumes of the two cones formed by radial elements passed around the two plane bases KMP and PML.

Since the plane segmental areas KMP and PML are readily computed, the method depends on the possibility of computing the surface area PKL. This computation is to be done as follows:

Describe great circle arcs XP and PZ. The spherical triangle ZPX has one side, ZX, equal to 90°; its side ZP is equal to ZT equal to ZL, which can be calculated; its angle X is measured by the subcircle arc PK; its angle Z is measured by the subcircle arc PL. Therefore the spherical triangle can be solved and its area determined.

Next considering the zone cut from the surface of the full sphere by the plane KPX, it is evident that the area

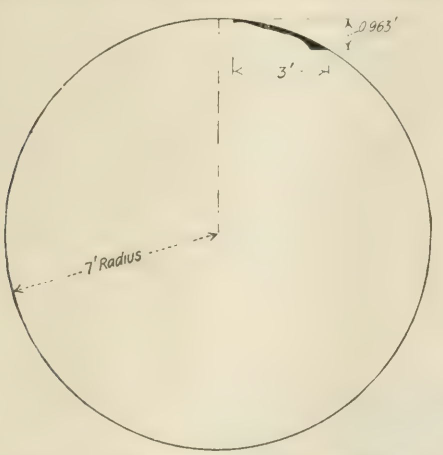


FIG. 1. SPHERE-SEGMENT PROBLEM

of the zone can be computed (equal to a meridian circumference of the sphere multiplied by the height of the zone) and that area KPX is a proportional part of this zone, measured by arc KP. This will give area KPX; by subtracting from ZPX the area ZPK is obtained.

Finally, the zone cut from the full sphere by plane PML is computed, and the sector ZPL is found as a proportional part of it, measured by the arc PL. Then, subtracting from ZPL the previously found area ZPK, the result is the desired surface area of the segment, or KPL.

The rest of the calculation is to multiply KPL by one-third of the radius, which gives the volume of the spherical cone O-KPL; multiply the plane area PML by one-third the altitude MN, and the plane area PMK by one-third the altitude MS, which gives the volumes of the oblique cones O-PML and O-PMK; and finally subtract the latter two volumes from the volume of the spherical cone.

In the original problem, the radius of the sphere was 7 ft., the width ML of the segment was 3 ft., and the

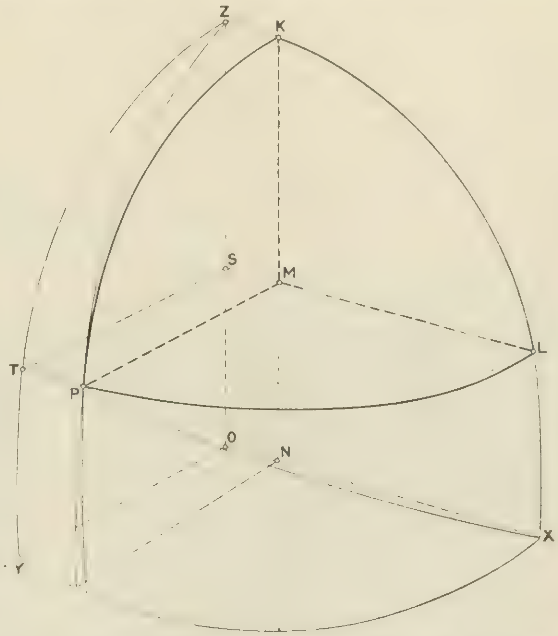


FIG. 2. CONSTRUCTION FOR ELEMENTARY SOLUTION OF SPHERE-SEGMENT PROBLEM

height MK was 0.963 ft. Applying to these figures the above method of calculation, Mr. Wardwell finds the volume (twice the volume shown in the sketch) to be 7.457. As a check, arithmetical calculation was used. First, the volume of the full segment cut off the solid sphere by plane $PLMS$ was found. Then the subtractive volume $PMKZST$ was computed by Simpson's formula, with three intermediate points between S and M. The full volume was 10.218, and the subtractive volume 2.762, giving the result 7.456.

This simple method may appeal to those who labored over the problem last year, especially those who struggled with the calculus solution and were not able to perform the integration.

Car Derricks for Handling Rails, Pipe and Timbers

Derricks and derrick-cars are used extensively by railways for loading and unloading rails at yards and on the track. Similar machines are used by railways, contractors and others for handling timbers, pipe, frogs and other heavy articles. Some of the machines described are on the market, but others are designed and built by railways for their own use.

For handling rails along the track, the New York Central R.R. uses steam locomotive cranes on main lines, but for side and branch lines it has air-hoist derrick-cars designed by its own staff and built at its shops at Corning, N. Y. One of these derrick cars is shown in Fig. 1. The machine is a 35-ft. flat-car, having at each

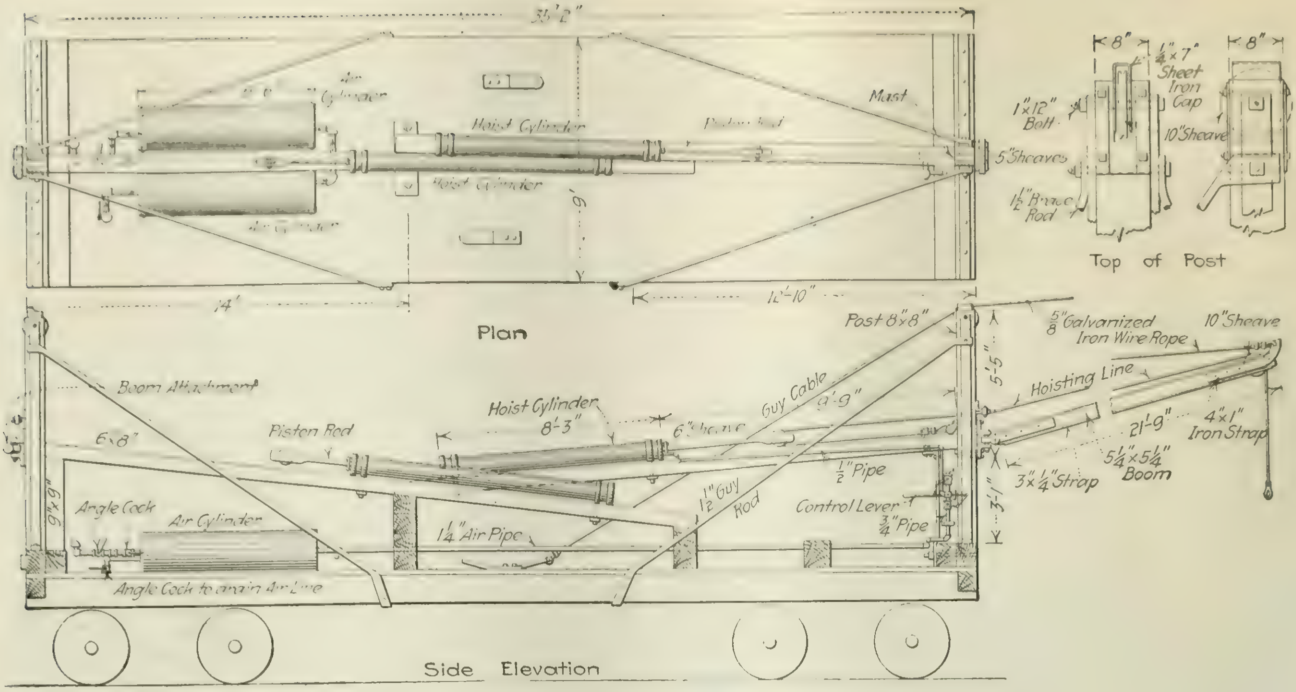


FIG. 1. RAIL-HANDLING DERRICK CAR FOR THE NEW YORK CENTRAL R.R.

end a mast 8½ ft. high. The mast is built up of two timbers kept apart by spacing blocks to permit the passage of the hoisting line between them. It is secured by brace rods bolted to the head of the mast and against the side sills of the car.

At about 3½ ft. from the floor the mast has an attachment for a boom, which is held a little above the horizontal position and can be swung laterally. The boom is about 22 ft. long and consists of a timber 5¼ in. square with an iron strap 3x¼ in. on top and bottom. The heel has a double swivel and the head has iron straps whose outer ends are bent up for the attachment of the guy line. The guy is a ⅝-in. wire rope passing over a sheave on the mast and having its ends fastened to the head of the boom and a lug on the floor of the car.

Behind each mast is an inclined timber carrying a 7½-in. air cylinder 8 ft. 3 in. long. The piston rod of this ends in a loop carrying a 6-in. sheave. The hoisting line, with one end anchored to the mast, leads back to the sheave, from which it returns to pass through the mast and between a pair of 5-in. horizontal guide sheaves, and out to the 10-in. sheave on the head of the boom. For each operating cylinder there is an air storage cylinder or receiver, with connections to the train-brake air-line, and all movements are controlled by a lever and valve mounted behind the mast, in convenient position for the operator. Information as to this device has been furnished by A. M. Clough, Supervisor of Track, Batavia, N. Y.

A Travis rail-loading machine was designed on the Fort Worth & Denver City Ry.; particulars of this have been given by R. C. Gowdy, Chief Engineer. The derrick was originally made portable, so as to travel along the flat cars in the same way as a ditching machine. This caused trouble, however, and the machine as now operated is mounted as a stationary derrick on a 43-ft. car. The original plan also provided for a mast and 20-ft. boom on each, but in later work one of these was removed and the other mounted at the middle of the derrick frame. The hoisting cable is operated by drums driven from a gasoline engine.

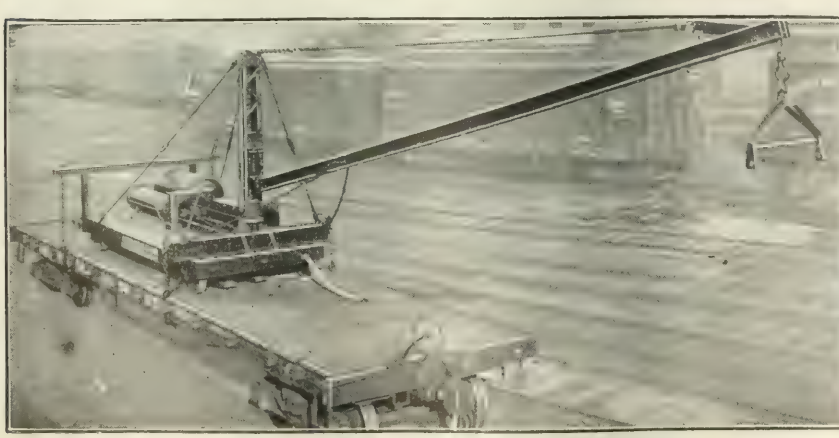


FIG. 2. PORTABLE RAIL-HANDLING DERRICK MOUNTED ON A FLAT CAR

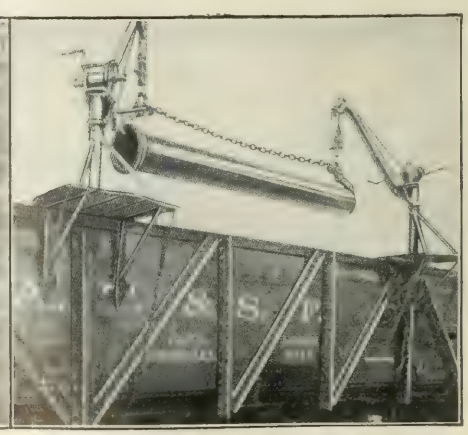


FIG. 3. LIGHT HAND DERRICK FITTED TO GONDOLA CAR

While the machine probably could be developed so as to be more efficient, the experience on this road has been that for handling small amounts of rail an ordinary derrick (provided with rail clamps) is faster, can be operated with fewer men, and is generally more satisfactory. The moving of the machine from car to car is not considered of much advantage, as ordinarily it is necessary to run the work train to a siding to get clear of regular trains before an entire carload of rails is picked up, and it is an easy matter to switch the derrick-car at that time. However, on roads of heavy traffic it might be very desirable to avoid this switching and rearranging of the work train.

The American rail-loader, shown in Fig. 2, consists of a four-wheel truck with mast and boom, all of steel construction. It has flat-tired wheels to travel along the floor of the car (flat or gondola), steel channels being provided as bridges to span the openings between cars. The hoist is operated by a compressed-air cylinder on the floor of the truck, and beside this is mounted an air reservoir. Flexible hose is provided for connection with the train pipe, as shown. This machine is built by the United Supply Manufacturing Co., of Chicago.

The Laas machine, built by the Chicago, Milwaukee & St. Paul Ry., was similar to this, but had the air cylinder on the boom. The Ware machine for unloading rails from gondola cars consisted of a gallows frame seated in pockets hooked to the sides of the car, and having two air-hoist cylinders suspended from the crossbeam. There were no cables, but each piston rod carried rail tongs. The device simply lifted the rails so that they could be slid down skids at the rear of the car as the train moved ahead. This was designed by Henry Ware, of Springville, N. Y., while Roadmaster for the Buffalo, Rochester & Pittsburgh R.R.

A larger and more elaborate device is the Brown rail-handling machine, which is a box-car having at each end an A-frame and low mast, with 22-ft. removable boom. The hoisting cables are led over sheaves and attached to the piston rods of horizontal compressed-air cylinders. With this machine placed between two rail cars, both cars can be loaded or unloaded simultaneously with two gangs. Each gang consists of an operator and four laborers. This rail-handling car is used on a number of large roads on which rail renewals represent considerable tonnage. It is sold by James C. Barr, 84 State St., Boston, Mass.

A simple outfit adaptable to a variety of purposes consists of a light portable hand derrick which can be mounted on the side of a gondola car. One or two derricks are used, according to the weight to be handled. The boom is carried by a short steel mast attached to a platform for the operator, this being hooked onto the top of the side of the car and secured by chains and braces on the outside, as shown in Fig. 3. The 1/4-in. cable is carried by a drum having two crank handles, the operator holding a handle in each hand. This derrick is built by the Taylor Portable Steel Derrick Co., of Chicago. It is used by railways and contractors, the former employing it particularly for handling cast-iron pipe, large timbers and other heavy freight.

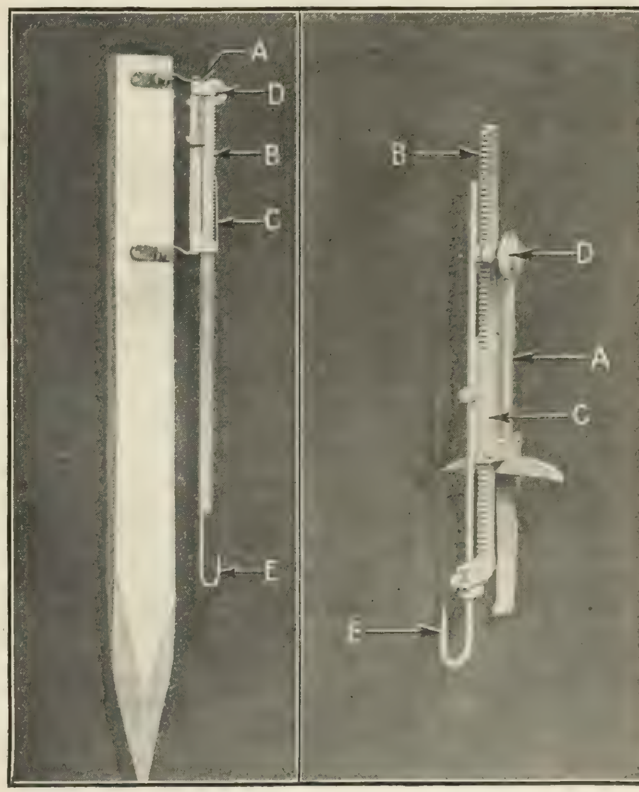
The boom (with drum) weighs 128 lb. and is detachable, having a cylindrical stem that fits within the hollow mast or post, which latter weighs 100 lb. The fixed reach is 3 ft. 4 in., and the height is 5 ft. from base of mast to hoisting block. The platform weighs 300 lb. including the chains and turnbuckles for securing it to the car. The cable can be rigged as a single, double or three-part tackle, to give increased capacity at lower speed. This derrick can be set up and removed very quickly. It is adapted for use at material yards and on construction work.

Convenient Form of Hook Gage

By R. B. Sleight*

The hook gage illustrated was developed by E. J. Hoff, of the Office of Public Roads and Rural Engineering, and has been in use by the engineers of the Division of Irrigation Investigations of that office for several years.

The instrument is made entirely of noncorrosive metal having a low coefficient of expansion. It consists essentially of the frame casting *A*, the rack *B* held in place



FIGS. 1 AND 2. HOFF HOOK GAGE OF THE OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING

by the spring *C* and actuated by the pinion *D*, and the hook *E* attached to this rack. Fig. 1 shows graduations of 0.01 ft. on the rack for 0.6 ft. This allows a movement of 0.5 ft. The vernier permits readings of 0.001 ft. The range of movement of the hook may be doubled or otherwise changed by sliding the bar up or down through the extended end of the rack, Fig. 2.

The instrument of Fig. 2 is designed for measurements of evaporation losses from tanks. The frame allows it to be set with three-point contact at a certain fixed datum on the rim of a tank or pan. It can be carried from place to place and relative measurements made without change for instrument correction or error. The gage of Fig. 1 is a type adapted to such uses as measurement

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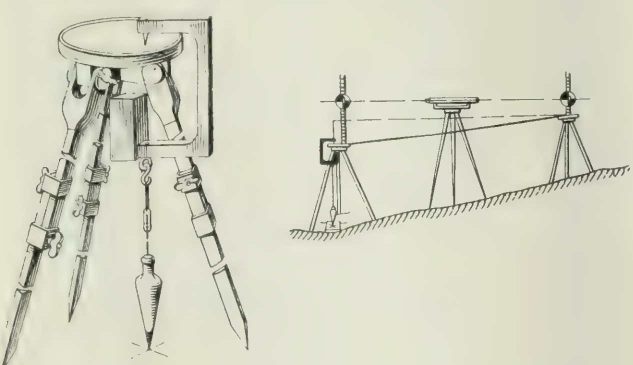
of head on a weir or canal elevations. It may be screwed to the weir box or stake, and by level and rod easily referred to any datum. When the rack is flush with the top of the frame, similar to the setting shown, the scale reading is zero. Therefore, scale readings may be used directly with rod readings taken from the top of the frame.

Some of the many good points of this little instrument are light weight, small size, portability, ease of adjustment and reading, and adaptability to various uses. It cannot warp or corrode under the action of water and air.

FINE AGGREGATE

Plumbing Instrument for Base-Line Work—The device illustrated is for reproducing a point from below to a point above, or vice versa, and is designed to be used in connection with base-line or other accurate tape measurements. It was devised in the Topographical Bureau, Borough of Queens, of which Charles U. Powell is Engineer in Charge. Distances are measured between points on the tops of small bronze tables mounted on steel extension tripods, the table tops being provided with white celluloid disks, on which the measurements are marked. The device consists of a cast-aluminum arm or bracket fitted with a steel pointer in the upper arm, and directly opposite it in the lower arm is a hook and eye for attaching the plumb line. It is held in perfect balance by a counterweight of lead incased in brass attached rigidly to



PLUMBING INSTRUMENT FOR BASE-LINE WORK

the lower arm, all parts made true and centered. In using, the instrument is brought directly over the point below by shifting on its pointer, and its position is marked above. As a test for error, the instrument is revolved 180° on its pointer. The instrument is designed to be carried in the pocket, its overall dimensions being about 4x6x1 in. and its weight 19 oz. A patent is pending. A center supporting rod with short sliding arm is set on the line of the table tops to overcome sag. Pluses are obtained with a steel tape and a plumb-bob. Eight men constitute a party, and from 8,000 to 10,000 ft. are measured in a day with an error not exceeding $^1/_{100000}$. A more detailed report on the making of the measurements was given in the Mar. 14, 1907, number of "Engineering News."

The Danger of an Exposed Flame in a city sewer tunnel was again demonstrated by an explosion, this time in St. Paul, Minn., on Nov. 29. About the only means generally taken of determining the presence of gas or gasoline vapor in sewers is by smell, which in this case was an unreliable means, as the conditions show. The 7x7-ft. sewer tunnel in which the explosion occurred is in sandstone, with a brick or granite-block invert 48 ft. below the street level, at the upper end, and on a 12% grade toward the river, where it has an outlet on a 5.65% grade. The explosion was caused by workmen who had erected a scaffold in a street manhole, which is 85 ft. deep, to repair the side walls at a point 35 ft. below the street level. Here four laterals 6x2½ ft. in size enter the manhole shaft. The men had lighted a candle and stepped from the scaffold into one of the laterals, when a blue flame circled about their feet and shot down the shaft. An explosion followed immediately, by which the scaffold was destroyed, but the men escaped unharmed. The explosion was felt for a block each side of the sewer, and several manhole covers were thrown upward. A sheet of flame and smoke was emitted from the outlet at the river. The explosion apparently was due to an accumulation of gases, probably gasoline vapor from garages and cleaning establishments. The workmen had noticed no odor of gasoline. It is probable that the lighter gases rising in the Third St. manhole acted as a fuse and ignited an explosive mixture of gasoline vapor and air in the tunnel below. The swinging gate at the sewer outlet was closed, as is customary in winter time, to shut off cold air currents. The catchbasins, which are untrapped, had also been shut off at their connection with the manholes in order to prevent the vapors of condensation rising from the sidewalk inlets on the street, for these are looked upon by the public as obnoxious from the fact that they come out of the sewers. The conditions were also very much aggravated by a heavy atmosphere outside. The tunnel was originally unlined; but as the softer rock disintegrated, repairs were made by lining these places with sewer brick. This brickwork was damaged to some extent.—George H. Herrold, St. Paul, Minn.

An Aid to Reservoir-Storage Studies—In studies of natural or artificial reservoirs for storage purposes, it frequently is necessary to determine the rise or fall in the surface level, due to certain rates of outflow and inflow. If the outflow is not constant for the varying levels, the required rise or fall due to a given inflow is ordinarily arrived at by a laborious trial method until a balance is reached between the various factors. For illustration of the method herein described, let a reservoir of 100 sq.mi. be assumed, with a discharge curve

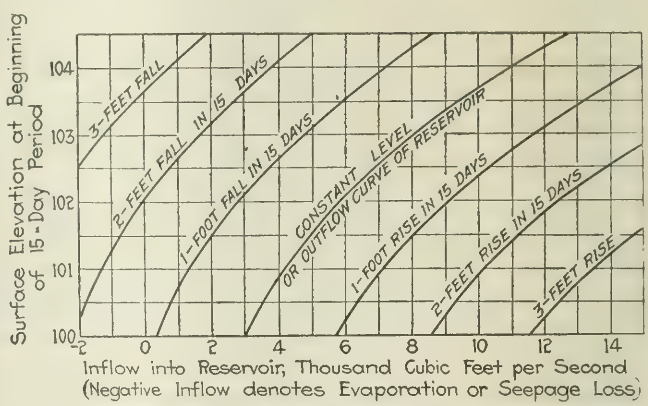


CHART FOR DETERMINING CHANGE IN SURFACE LEVEL OF RESERVOIR

as shown by the heavy line in the figure. The theoretical rate of inflow (including rainfall on, and evaporation and seepage from the reservoir) is equal to the average rate of outflow from the reservoir plus or minus the rate produced by the rise or fall in the surface level over the given period. By assuming several initial levels within the limit of probable requirements, and several rates of rise and fall during a period of 15 days, the corresponding inflow is determined, upon which the remaining curves in the figure are based. In using such a chart the above process is merely reversed. Given any inflow, and a certain reservoir level at the beginning of the period, the rise or fall during the period may be directly taken off. For a level of 102 and an inflow of 10,000 sec-ft., the reservoir will rise 1.25 ft. during the half month. The chart may be constructed for any shape of outflow curve, and for any period of time, and where there are a considerable number of computations to be made it will prove a time-saver.—George M. Shepard, Assistant Engineer with Adolph F. Meyer (Consulting Engineer), Minneapolis, Minn.

Brick Pavements Versus Traction-Engine Parades—We have about 32,000 sq.yd. of brick pavement in Billings, Mont., all laid in 1910. After the brick had been in service about a year, there was a convention of traction-engine manufacturers; and they had a big parade in town, and the citizens of course, were all worked up because the Billings Boosters wanted to keep these people in town. So they decided to have the parade up Montana Ave. and over the bricks, and they came up to the city hall and asked if it would be satisfactory to do this, and the city engineer said it would not. One of the principal Boosters said, "We don't want any grass to grow on our streets; wear out these bricks, and we'll put down some more." As a matter of fact, the traction engines used our bricks pretty severely, and we have had quite a lot of trouble because of this traffic.—John Edy, Highway Engineer, Billings, Mont.

Editorials

Chief of Engineers' Report on Seacoast Defenses of the United States

As a result of the discussion on national preparedness during the past year or more, it has become generally known that the fortifications on which the United States relies for the defense of its principal seaports are very far from constituting the complete protection against attack by a hostile force that the general public has hitherto supposed. Especial interest, therefore, attaches to the remarks on coast defenses in the annual report of Gen. William M. Black, Chief of Engineers, just issued.

Few realize, probably, that the existing coast defenses of the United States were planned by a board that made its report in 1886, *thirty-one years ago.* It is true that twenty years later a second board, of which ex-President William H. Taft, then Secretary of War, was the head, reviewed the coast defenses of the country and recommended various additional works; but the greater part of that board's recommendations had to do with such accessories as fire control, provision of searchlights, power plants, defenses by submarines, mines, etc., rather than with the construction and location of new fortifications.

The fortifications planned by the board of 1886 were adequate for that day, but there have been revolutionary changes in the conduct of warfare in the thirty years since. The European War has made these changes matters of common knowledge at the present day. General Black says in his report:

> When designed and constructed, our seacoast batteries were thoroughly modern; but the work of battery construction has in the past few years been allowed to practically cease and has not kept pace with the recent progress in naval development.
>
> It cannot be too emphatically stated that the art of fortification must continually grow to keep pace with the new discoveries which give it special advantages or to meet and offset progress in the development of naval vessels against which the forts are expected to contend. In locating and designing batteries, the range and power of the naval guns must be given consideration, and unless our fortifications are to become obsolete, changes in any of the elements of naval defense must be met by corresponding changes in seacoast batteries.
>
> These changes must in most cases consist in the construction of absolutely new batteries in new locations. The older batteries were necessarily designed and located so as to obtain the maximum effect with guns of a certain range. If more powerful and longer-range guns were mounted in these older batteries, a large proportion of this increased power and range will in most cases be lost.

In discussing the present condition of our seacoast batteries it must be remembered that the chain of defense which prevents a hostile force from successfully attacking a seaport is no stronger than its weakest link; and the guns and fortifications at the entrances to our seacoast harbors are not the weakest link in this chain of defense. It has long been proverbial in military science that ships cannot successfully attack fortifications. This was proved by experience in the Spanish War and in the Russo-Japanese War, and notably in the present war by the unsuccessful attempt to capture Gallipoli. Although our seacoast batteries fall short of what they should be to cope with the latest type of naval vessels, it is probable that a hostile force would choose other means of reducing them than direct gunfire. Concerning this, General Black says:

> Experience has shown that a direct attack of land fortifications from the sea is so hazardous to the attacking fleet and so rarely successful as not to be undertaken under ordinary circumstances. The attack usually is made from the land by an expeditionary force placed on shore at a point distant from and not covered by harbor-defense guns. Such an attack would be supplemented by attacks from the air.
>
> Adequate preparation for defense against these attacks has not yet been made. Mobile army forces must be available on the exposed frontier in numbers sufficient to provide for patrols along the shores, for outposts to reinforce the patrols and for a reserve close enough to reach the threatened point before any large enemy force can be debarked and can secure its position by intrenching. Field artillery of all classes must be provided; armored trains, with and without heavy ordnance, must be provided for the patrol of exposed coasts bordered by railways; and—equally important—anti-aircraft guns must be provided in numbers for protection of our fixed military utilities against destructive attacks from the air. Comparatively little has as yet been done along these lines.

This statement of the danger which would threaten American seacoast cities in case of attack by a hostile force is of course not new; but to have it thus authoritatively stated by the Chief of Engineers of the Army should end all controversy as to the facts of the case.

Engineers Discuss Americanization

It is significant, surely, of a revolutionary change in social standards and ideals when one of the most famous mansions of New York City, which once represented all that was most exclusive in ultrafashionable society, opens its doors to a great gathering of American engineers, not as a purely social affair but to discuss the methods by which engineers may take a leading part in the task of making foreign immigrants into real American citizens.

Mr. and Mrs. Vincent Astor gave a dinner last Friday evening, at the Astor residence on Fifth Avenue, to 170 prominent members of the American engineering profession, in coöperation with the Committee on Immigration of the National Chamber of Commerce. Last year several luncheons were given by Mr. and Mrs. Astor and other leaders of New York society in connection with the organization of a committee to provide plans for better housing facilities for the poorer classes of industrial workers. This is considered one of the most practical steps in Americanizing the immigrants from foreign lands.

The question may fairly be asked, what are the practical things that the engineer can do to further the work of creating a true American spirit in those who come to this country from foreign shores, and also, as was brought out by one of the after-dinner speakers last Friday night, among the many natives of America who are sadly lacking in any realization of responsibility for their citizenship.

To fully answer this question would require a volume; at this, at least, can be said, that engineers as a class

are at least as fully alive to their duties as patriotic citizens as are the men of any profession or occupation.

A fine illustration of the patriotic spirit among engineers was the prompt and hearty response of the engineering profession to the appeal for aid made by the Naval Consulting Board last year in preparing the inventory of American manufacturing industries. Another illustration is the widespread interest shown by engineers in the courses of lectures on military training in the practice camps and other movements of the past year aimed to arouse Americans to a better conception of their national duty.

Engineers are well aware that the general treatment of immigrants employed on construction work or in factories has until recently been open to criticism from many points of view. A great change in these conditions has already been brought about, partly through the initiative of some of the large employers of labor, partly through the admirable work done by the international Young Men's Christian Association in developing courses of instruction in "human engineering" in the leading engineering schools, and partly as the result of conditions in the labor market.

It is unfortunately true, however, that on many classes of work for which the engineer bears responsibility, those who hold the purse strings have placed so much emphasis on efficiency and economy that there has been no time or money left to devote to the work of bettering the condition of the human beings who are employed. Where conditions are such that the engineer can do something practical for the men under his direction, he will generally be found ready to take the lead in this most important work.

Inadequate Railway Terminals and the High Cost of Living

A joint report has recently been made on food supplies and prices for New York City, by three committees—one appointed by Governor Whitman of New York, another by the New York Legislature, the third by Mayor Mitchel of New York City. In a chapter of this report dealing with the relation of the means for transportation to high prices for food the committee says:

> It has been estimated that it costs very much more to transport a pound of food from the point where it lands on reaching New York to the home of the consumer than it does to bring it by rail all the way from Buffalo to New York. The present inadequate track, yard and terminal facilities of the New York Central R.R. are serious handicaps to the producer in the marketing of food products. A thousand or more cars at a time are often held up north of Spuyten Duyvil. The yards at 130th St., 60th St. and 30th St. are so inadequate as often to cause 150 to 200 cars of produce at a time to be held on back tracks awaiting placement on team tracks. Cars loaded with produce are sometimes detained in these yards on an average of five days beyond the free time of two days. The consequence is a large additional expense, a shortage of produce cars and the issuing of embargoes, with such demoralization that farmers often hesitate to ship to New York City and endeavor to seek markets outside the state. Similar conditions exist with practically all the transportation companies.

There is no question as to the facts that the committee recites, but the question how to solve the difficulty is one not easy to answer. The New York Central has made plans for expending some $50,000,000 to provide better means for bringing its freight and passenger traffic into New York City on its west-side lines. Some experts who have studied this problem, however, believe that when the interest, taxes and sinking-fund charges on this huge investment are included, the cost of handling cars on the New York Central's new west-side lines can hardly be less than at present.

The delays due to congestion may indeed be remedied for a while; but it will be no very long time, presumably, before the capacity of these terminals also will be reached and exceeded. Probably there is no really cheap way of handling freight cars on Manhattan Island.

It is difficult to propose anything better for the traffic from the north over the New York Central lines, admittedly. To the westward, however, in New Jersey, there is still plenty of room for adequate railway terminals, which would be much nearer to the congested regions of New York that must be supplied with food than are the uptown yards of the New York Central. Such a solution is dependent, manifestly, on more adequate means of crossing the North River; and the problem of bridges or additional tunnels there is one that is receiving increased attention.

Automobile-Engineering Development

The American Society of Automobile Engineers held its annual meeting on Jan. 11 in the auditorium of the Engineering Societies Building. This society, which was not dreamed of when that building was constructed a dozen years ago, has now a membership of over 2000; and it filled the auditorium with such a large audience as has seldom been assembled there at any technical meeting, even of the great national engineering societies. The papers presented at the meeting were as scientific in their character and as well entitled to rank as engineering literature as are the papers read before any of the older national societies.

In the early days of the automobile it used to be predicted that its coming was a passing fad and that it would disappear as quickly when the fashion changed as did its predecessor, the bicycle. Few would be found today to take this superficial view. The engineers of the automobile industry who are applying mechanical power to road locomotion are dealing with as great a problem and are devoting vastly more scientific methods to its solution than did the engineers of eighty years ago who applied mechanical power to railway transportation.

The motor vehicle is already producing social and economic changes quite comparable with those wrought by the locomotive. The rapid growth of the industry is the most amazing illustration the world has ever seen of the possibilities in the large-scale manufacture of machinery.

In the commercial-vehicle field the displacement of the horse has been slower; but the last two years have seen a great advance in the use of the motor truck and delivery car. The high price of feed and of horses since the war began has stimulated the demand for motor vehicles. The business is also rapidly developing of transforming second-hand pleasure cars into commercial vehicles. The farm tractor is being rapidly developed and improved to a point where it will become a much stronger competitor of the horse.

A question that has been seriously raised many times during the past two years is whether a limit to the development of the motor vehicle will not be set by the lack of fuel to supply the enormous and rapidly increasing demand. That higher prices for motor gasoline are inevitable is generally agreed by those qualified to judge.

Present prices of crude petroleum in Eastern fields are higher than have ever before been recorded. A large proportion of the newer oil fields produce heavy asphaltum oils, from which only a small percentage of gasoline can be extracted.

The first solution of the problem of fuel supply will doubtless be through the use of heavier oils. With the motor boat and the farm tractor, the use of kerosene is already practicable. On many commercial automobiles no very great changes in construction will be required to make possible the mixture of a large percentage of kerosene with the gasoline.

The operation of the motor vehicle is, moreover, not wholly dependent on gasoline. Even at present prices of motor fuel the storage-battery vehicle is an important competitor of the gasoline motor truck and pleasure car.

Another possible competitor for the gasoline vehicle is the steam car. At the recent New York Automobile Show the exhibit that attracted the greatest amount of attention was the new steam automobile which has been developed by Abner Doble, of California, an engineer who has been a prominent figure in water-development.

Among the novel features of the Doble steam car are a sectional water-tube boiler, with autogenous-welded joints, which is claimed to be so rugged and to have so small a water volume that steam pressure can be raised in one minute after lighting the fire. Kerosene serves for fuel, ignited by a spark; and a slow-speed uni-flow engine is used, connected to the rear axle so that a large part of the mechanism of the gasoline automobile—clutch, transmission gear, etc.—is eliminated. Fuel economy practically equal to that of a gasoline car is claimed.

It will be obvious that the steam motor vehicle has much greater possibilities in the application of low-grade fuels than the car driven by a gasoline engine. The advance in the price of gasoline will therefore give a stimulus to the development of the rival system. It may fairly be concluded that the application of mechanical power to road transportation will not come to a halt because of lack of fuel.

Salaries of Government Engineers

Interesting sidelights on the compensation of engineers in the Federal Government service are contained in the 1916 annual report of the Superintendent of the United States Coast and Geodetic Survey. He prefaces his plea for increases in salaries for the survey's hydrographic and geodetic engineers by the following:

> The old theory about the civilian appointments in the Government was that any man was fortunate who retained his job for more than four years, however insignificant the position and however small the pay. This was in the days before it was found necessary to enact civil-service laws and put them into effect. Now the Government considers itself very fortunate if it can retain experts in its service for more than four years at salaries much smaller than those ruling in similar work in private life.
>
> The Government is the largest single employer of skilled labor (for the sake of argument, calling all who work for salaries or wages laborers) in the country. It is also the most inefficient employer. It sees 15 or a larger per cent. of its skilled employees leave each year. These are, as a general rule, the most able and most efficient ones. The least able ones remain, and on account of long and faithful, but many times not notably efficient, service they reach the highest salaries.

The report then outlines the difficulty in keeping Survey officers: In the six years since 1909, out of a total of 99 field officers 66 have resigned their positions. This does not include any vacancies on account of death. Nearly all resigned to take up work paying higher salaries or with prospects of an increased income, or because of the hardships incident to the life of a field officer in the Survey.

The report contains the accompanying table of comparative average salaries. The conclusion stated is that the Coast and Geodetic Survey officers are the poorest paid of any of the Government engineers and that Government employees as a whole are poorly paid.

COMPARATIVE SALARIES OF ENGINEERS

Service	Average Pay	Reference
American Society of Civil Engineers*	$4,141	Report of committee of society, January, 1917
41 civil engineers, United States Navy	3,429	1916 Estimates, p. 1078
226 engineers, United States Army	3,008	1916 Estimates, p. 292
Geologists, Geological Survey (73 annual employees)	2,130	1916 Estimates, pp. 791-798
Topographers, Geological Survey (57 annual employees)	2,164	1916 Estimates, p. 792
Bureau of Mines (34 annual employees)	2,662	1916 Estimates, p. 806
Patent Office (396 annual employees)	2,019	1916 Estimates, p. 95
Hydrographic and geodetic engineers, Coast and Geodetic Survey (104 annual employees)	1,720	1917 Sundry Civil Act
Hydrographic and geodetic engineers, if granted increase requested (152 annual employees)	1,900	1918 Estimates

*The Survey report gives the average of the 1915 report of the Am. Soc. C.E.

In interpreting these figures, however, there are several points not mentioned in the Coast Survey report which it is necessary to know to make a fair comparison. First, the Government salaries include everyone and are real averages, while the American Society average undoubtedly includes a larger proportion of the higher-salaried men than of the lower-salaried ones. One-third of the members made no returns, and if this third were the low-salaried third, as it is permissible to asume, the general average would be much reduced, if this average were made comparable with the Government figures

Again, many Government engineers are allowed regular sums for subsistence when away from headquarters. Coast Survey officers, for instance, are allowed $2.50 per day when acting as chiefs of parties and in the Philippines. All other officers are allowed $2, except aboard ships on our own coasts, where the allowance is $1 per day. These sums are paid outright, and they are not necessarily actual living expenses. An officer who spends nine months a year in the field as chief of a geodetic or a hydrographic party may thus have a salary of $1800 per annum and a commuted subsistence allowance of 270 × $2.50 = $675, or a total income of $2475. In reporting his professional income to the American Society he could properly give $2500, while the remuneration of the same individual appears in the Government table as $1800.

If the Coast Survey finds it hard to fill up its roster of officers, these facts should be just as widely published as the others. Moreover, it is certainly unjust to the many able and efficient officers now in the service to state that "the least able employees remain." Many a young fellow goes into the Coast Survey for the specific purpose of getting a year or two of its training and then quitting.

Like every other organization, the real working personnel of the Survey represents the survival of the fittest —those who love the work for the work's sake; these are the real workers in all professions. That their salaries are low and should be increased to meet modern living conditions is only too true, but the same holds true of a large proportion of the salaried men in many callings, especially those in scientific pursuits.

Letters to the Editor

The Ohio Conservancy Act

Sir—In "Engineering News," Dec. 21, 1916, p. 1190, Clemens Herschel criticizes the Ohio Conservancy Act. He begins:

> Let us briefly review the act. It provides for the appointment in any county of commissioners. Note that two mistakes have already been made, for (1) County lines are no proper boundary of jurisdiction in matters of engineering construction, especially not for flood protection; (2) nor is an emergency commission of laymen a proper body to oversee to the best advantage the design, construction, operation and maintenance of such works.

Unfortunately neither of these two statements is true. The law provides for the organization of conservancy districts entirely regardless of county lines. The fact that the Upper Scioto Conservancy District, with which Mr. Herschel had a brief acquaintance, accidentally lies in a single county may have led him to reach his conclusion without having read the act itself.

Under the act a conservancy district becomes a corporate body governed by a board of directors much as a railroad company is governed. To call a body of directors laymen because they are not engineers is to assume that such a district has no functions except those of an engineering nature, just as in a similar case we might assume that all the functions of a railroad are engineering functions and that therefore a board of directors not consisting of engineers would be a board of laymen.

Mr. Herschel also states that the law should "operate on drainage areas and not counties or parts of counties or on parts of drainage areas." This is an academic statement which falls completely when examined in detail. Is a drainage area the Ohio River with its branches, or the Miami River and its branches, or one of the branches of the Miami River? Must we assume that until an entire drainage area on a river is ready for improvement no part of this area can be improved? Can no marsh be drained, can no city be protected, except through an organization comprising the entire drainage area? Theoretically this is a fine ideal, but those who have watched the actual development of our Western States know that it is impossible—and the engineering profession gains in prestige and influence in proportion as it realizes what methods are effective and possible in public improvement and keeps away from schemes which are entirely impracticable. To confine any large drainage area in Ohio to a single organization requiring the action of the entire organization to bring about any improvement, whether that improvement be a village ditch or a great flood-prevention works, would result in preventing entirely the effective operation of a water-control code. The Ohio Conservancy Act very wisely provides that the determination as to whether an entire drainage area, or only a part of it, should be included in a conservancy district should be made upon the facts presented in each particular case and not upon any theoretical assumption made in the statute itself.

The writer thoroughly agrees with Mr. Herschel that:

> We are approaching the day, if it is not already here, when permanent organizations for the construction and care of all public works will have to be provided for.

Whether it is time for such an organization in any state can only be determined by a knowledge of conditions in that state. In general it is true that unless a need for such an organization is felt before such an organization is created, its creation is apt to be a matter of politics. In one state where such an organization has been created a country newspaper editor has been placed in charge of the bureau and is acting as consulting engineer on the reclamation projects of the state. Any engineer who does not become a part of his political organization is not looked upon with favor. In another case a state officer who is not an engineer and has no training or experience in engineering is given charge of the water-control functions within the state, and has it specifically in his power to pass upon the qualifications of every engineer employed on such work within the state. It has been said that he is using this power for definite political ends. These are simply illustrations to indicate that whether or not the time has arrived for the creation of a state bureau depends upon local conditions, a knowledge of which is required before an accurate judgment can be expressed.

In his statement of engineering facts, Mr. Herschel is also in error. Speaking of the plans of the officials of the Upper Scioto Conservancy District, Mr. Herschel states that it was "no concern of theirs that this would spoil the plans of the Franklin County Conservancy District, for they are looking out only for their immediate clients or petitioners." The fact of the matter is that the plans of the two districts were considered as to the effect of the upper upon the lower, and it was found that the work of the upper district, which controlled less than 10% of the entire drainage area, would have very slight effect upon the works below. The plans of the two districts were worked out in harmony.

Dayton, Ohio, Dec. 30, 1916. ARTHUR E. MORGAN.

Good Roads Not an Invidious Benefit to Motor Truck Owners

Sir—I have read with a good deal of interest Prof. C. C. Williams' letter to you relative to duplication of transportation facilities, in your issue of Jan. 11, 1917, p. 80.

As I understand it, Professor Williams takes the attitude that it is unwise to build trunk-line highways between cities, but that it would be wiser to devote state moneys to the building of better highways locally.

The writer is compelled to disagree with Professor Williams' conclusions as stated above for the following reasons:

There has been an enormous growth in the use of commercial vehicles by the farmers to bring their material to the local freight stations, and the advantages in many instances which accrued in this way encouraged the farmer to bring his material direct to the city markets. The writer has noticed an exceedingly large number of motor vehicles employed in the States of New York and New Jersey by farmers, bringing in garden produce to city markets from distances up to 50 mi. It would not pay the farmer of course to bring grain, oats and other commodities which are staples any such distance with motor trucks, if convenient railroad facilities were available, but the railroad rates on perishable freight are so high, together with the fact that the farmer is enabled by the use of motor trucks to deliver his garden produce so much quicker, with so many less handlings to the city market, that the products arrive in much better condition, thus being worth much more money. Further this enables the farmers to sell direct to the retailers, rather than through jobbers and other middlemen.

The summation of these reasons makes it very advantageous to the farmer to utilize motor trucks instead of railroads for garden produce, and correspondingly enables the city dweller to purchase the goods in better condition for less money.

The writer wishes to call attention to the fact that in many instances railroads were projected through territory where population and freight were very scarce, but where future possibilities of development justified the building of the railroad. The same condition applies to the building of good roads of such a character that they can be utilized for commercial traffic, not only in regions which are parallel with railroads, but also regions where railroads are more or less remote, for some of the railroads have reached the mental state where they are encouraging commercial motor transportation as feeders to their system.

While this last statement would seem somewhat contradictory, upon analysis the real underlying meaning will appear.

The writer wishes to call attention to the fact that in most states state funds are not contributed in any degree to the initial building of new roads or the maintenance of old roads, within municipalities.

In most instances railroads have been projected through regions which showed possibilities of traffic developing. State roads built through these regions naturally would be of service to more people than roads built through sparsely populated regions, except in the case where regions are sparsely populated owing to the fact that they are inaccessible, rather than on account of their lack of fertility.

There are many fallacies and misconceptions regarding the usage of commercial motor vehicles, and one of them is that the apparent attitude many people take that operators of

motor vehicles are specially favored when good roads are placed at their disposal.

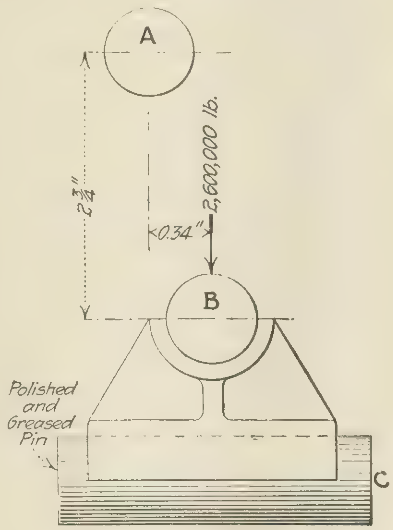
It should be distinctly understood that nobody operates a commercial vehicle except for utilitarian purposes and that the benefit which accrues from such usage, in some way or other is beneficial to the people as a whole and not alone to the person or concern which operates these trucks, for the same principal that underlies all business, and that is, that any service rendered must be of more value to the purchaser than what he pays for it. GEORGE H. PRIDE.

1328 Broadway, New York City, Jan. 20, 1917

Support of Quebec Suspended Span

Sir—I should like to submit as a comment on R. S. Foulds' letter in your issue of Dec. 21, 1916, the accompanying sketch, with the query, How did pin C freeze in the horizontal position? This query will be understood by anyone who has followed the matter of the alleged stability, not strength, of the Quebec Bridge lifting scheme, but a little explanation may serve to make it clearer to those who have not followed current comments on this disaster.

A represents the lowest pin in the suspending chain of bars about which the girder supporting the truss shoe could rock; B is the pin carrying the end post of the truss, and C is the longitudinal pin. The idea meant to be conveyed by the sketch is the absurdity of the pin C remaining horizontal when the girder supporting it was lifted, as Mr. Foulds' letter indicated it would, because the friction on the pin A was too great for it to rotate in spite of the tremendous load and the lever arm of 0.34 in. and the jarring due to lifting. These pins were well polished and well greased. In my judgment, as the girder was lifted and jarred, the pin B would rapidly find its place vertically below A; and even if the offset were only a trifle over ⅛ in., as suggested in Mr. Foulds' first letter, the slope would be sufficient to be the sole cause of the wreck of this bridge.



SKETCH OF PINS AT END SUPPORT, QUEBEC BRIDGE, SUSPENDED SPAN

EDWARD GODFREY.

Monongahela Bank Building, Pittsburgh, Penn., Dec. 26, 1916.

Decimal Angular Measurements and Centesimal Division of Quadrant

Sir—Referring to a letter entitled "Field-Artillery Service for Civilian Engineers," in "Engineering News" of Sept. 21, 1916, p. 564, the editorial tail note of that letter states: "The incipient surveyor-inventor looking for opportunities to introduce new methods may possibly see the germ of a valuable improvement in the decimal system above described."

One of the things quite apparent in the discussion of the method of an artilleryman's measurement of angles is that a decimal measurement of angles is the only one that can be performed with speed. Further, the time that might be saved by all who measure angles and compute trigonometrical functions in all lines of work by the use of a decimal division of the circle would be great. It seems that is beyond dispute.

However, no engineer could be induced to order instruments graduated to read decimal parts of the circle or quadrant, unless he had at hand tables of functions for such division, and tables to convert the present system into the decimal system and vice versa.

In the 1873 "Proceedings" of the British Association for the Advancement of Science may be found a complete catalog of all the mathematical tables published up to that time. Two books listed have tables for the centesimal division of the quadrant. They are: (1) "Log Functions," by Charles Borda—that is, Charles de Jean; (2) Hobert and Ideler's seven-place tables (published in 1799). Concerning Hobert and Ideler's tables the following is said:

(T. 1.) Natural and logarithmic sines, cosines, tangents and cotangents for the quadrant, divided centesimally; functions given for arguments from 0.00001 to 0.03000 of a right angle at intervals of 0.00001 of a right angle, and from 0.03000 to 0.50000 at intervals of 0.00010 to seven places, with differences.

Expressed in grades (centesimal degrees), etc., the arguments proceed to 3^g at intervals of 10″, and thence to 50^g at intervals of 1′.

The manner of calculation of the table is fully explained in the introduction, and this adds much to the value of the work. Several of the fundamenta were calculated to a great many places. Two or three constants are given on page 310.

B. Table of natural sines and tangents for the first 100 ten-thousandths (namely, for 0.0001, 0.0002, etc.) of a right angle, to ten places.

C. Four tables, expressing (1) 1°, 2°, 3°, ...89°; (2) 1′, 2′, 3′,....59′; (3) 1″, 2″, 3″, ...59″; (4) 1‴, 2‴, 3‴, ...59‴; all as decimals of 90°, to 14 places.

D. Three tables to express (1) hundredths, (2) thousandths, (3) ten-thousandths of 90°, in degrees, minutes and seconds (sexagesimal).

E. Four tables to express (1) hours, (2) minutes, (3) seconds, (4) thirds, as decimals of a day.

F. Small table to express decimals of a day in hours, minutes and seconds.

Unfortunately, Hobert and Ideler's tables do not include under Table 1 external secants and versines, with differences. If they did, they would be complete enough and close enough (with seven places) for ordinary engineering work, including ordinary triangulation. One virtue they possess is the differences columns. This is very essential for speed in interpolation. The arrangement of tables, also, so that functions that may be needed most often consecutively be listed together, is another important matter. The arrangement of James Pryde's "Mathematical Tables" is good.

I am unable to secure a copy of Hobert and Ideler's tables even for inspection. Possibly some of your readers might be able to suggest other authors of similar centesimal tables or canons who published their works subsequently to 1873. I should like to know whether the work of Hobert and Ideler may be found in the engineering libraries in New York. Apparently no copy can be found in Washington, D. C.

It seems unfortunate that the centesimal division of the quadrant was superseded by the sexagesimal.

VIRGIL A. EBERLY.

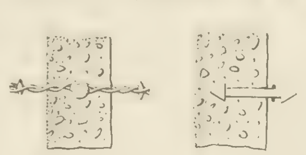
Washington, D. C., Jan. 4, 1917.

NOTES AND QUERIES

Pumping Concrete—An engineer having a railway tunnel to line with concrete has inquired as to the possibility of pumping the concrete from a mixer plant at the portal through a delivery pipe leading to the forms. It is desired to compare this with the method of mixing and delivering concrete by compressed air, which system has been used in a number of tunnels.

A Bridge Draftsman Arrested—A draftsman going under the name of Robert J. MacNoll, who was advertised for in "Engineering News" of Jan. 4, was arrested in St. Louis on Jan. 11 on charges of forgery and grand larceny. His arrest was the result of publicity given to his operations at a meeting of the Engineers' Club of St. Louis on Jan. 10. From such information as has been obtained, he has defrauded engineers in Pittsburgh, Chicago and various Western cities, and will now probably receive a penitentiary sentence.

An Attachment for Wire on Concrete Fence Posts has been devised by W. E. Mielly, Engineer of the Contracting and Material Co., Chicago, and he is anxious to know both if the method is practical or if it has been used before. The scheme is to embed a double cone-headed nail in the post about as shown in the sketch, leaving one head and a small part of the shank exposed. After the post is erected and the wire stretched, the double strands of the wire would be forced apart and over the head of the nail. Mr. Mielly says: "It would have to be made of rustless iron or have a thick coating of zinc applied, to make it last as long as the post. I think the cost would not be greater than the ordinary staple. The opinion of those who have had experience along the above lines would be appreciated."



Gypsum-Composition Roof Slabs To Be Used by Navy Department

The Bureau of Yards and Docks, United States Navy, has just awarded a contract for the roof of the new structural shop at the navy yard at Norfolk, Va., for a roof slab to be constructed of gypsum composition, because, according to the official statement, of the saving in weight of structural steel resulting from using a roof slab so much lighter than reinforced concrete and also because of the anticipated saving from the reduction of heat losses through the relative nonconductivity of gypsum as against concrete. This contract was let so that the unit cost of the gypsum slab complete will be about 22.2c. per sq.ft.

In Bulletin No. 25 of the Public Works of the Navy, issued by the bureau, there is considerable space devoted to the subject of gypsum-composition slab construction, mainly a report of investigations made by the bureau before deciding on the use of the material for the building. These investigations consist in inspections of installations of gypsum-composition slab construction and a loading test of a typical floor slab made by the United States Bureau of Standards. Extracts are given below from the reports of the various installations examined.

Civil Engineer George A. McKay, U.S.N., inspected different slab constructions of the Midvale Steel Co., the Baldwin Locomotive Works (Eddystone), Remington Arms (Eddystone), Pennsylvania Shipbuilding Plant (Gloucester) and other installations. He reports partly as follows:

The largest installation seen was at Eddystone, where there are built about 22 acres of roof covered with gypsum-composition slabs. Certain of these slabs have been in use for as long as six years. All slabs inspected were installed in accordance with the table of spans, slab depths and cable spacing and represented standard construction of the Keystone Fireproofing Co. The superintendents of construction or their assistants at the different plants were interviewed, and all information gathered either by inspection or by interview was favorable.

Particular attention was given to the work being installed on Ordnance Machine Shop No. 7, Midvale Steel Co. The roof slabs were 3 in. thick, spans 6 ft. 3 in., reinforcement consisting of two No. 11 wires 3 in. on centers, wires being held down in the center of the span by one ⅝-in. round bar. This slab is designed for 30 lb. live-load. Beam lengths were 17 ft. 6 in.; the end panels were stiffened with three 1½-in. pipe struts, and the center panels were stiffened with one 1½-in. pipe strut. In the end two panels there was a 6x6-in. gypsum beam, 6 ft. 3 in. long, installed for further stiffening of the end slabs. The gypsum composition used contained 15% by weight of wood chips and heavy broken shavings. The bulk of this wood filler, however, was considerable, so that in appearance there was apparently much more wood filler than gypsum.

The gypsum and wood chips were first mixed dry by hand turning, similar to hand concrete mixing, on the ground; were then loaded into sacks, raised to roof by elevator and transported to the site of the work, where the mixture of gypsum and wood chips was again mixed in a box, water being added at the same time. The mixture was then immediately shoveled on the forms and screeded to proper elevation.

The company's force consisted of a total of 75 men, which force laid 7500 sq.ft. per day. There were about 12 men dry mixing, 2 men on hoist and 8 men for wet mixing and screeding. The remaining men were employed placing reinforcement and forms, stripping forms and on miscellaneous work. Within 15 min. after a slab was poured it was possible to step upon it without leaving a footprint. A slab that had been poured at 9 o'clock had the form stripped at 11 o'clock. Seventeen men were then put on this slab in a space about 8x6¼ ft., which represented a live-load about double that for which the slab had been calculated. The slab adjacent to the one loaded was without load. No deflection was noticeable to the eye, and there was no apparent injury to the construction. At the time this first load was applied, the gypsum slab was so soft that it could be slightly compressed under the pressure of the thumb. The gypsum slab construction is quite elastic, and when compared to concrete is comparatively soft under foot, particularly so until it has thoroughly dried out, which takes about three weeks' time.

Civil Engineer L. M. Cox, U.S.N., reported on certain installations around New York City, with the following general abstracts:

The advantages of gypsum slab construction are:

A. The light weight of slab, thereby reducing dead-loads and decreasing cost of steel, foundations and piles.

B. Quick construction, as forms can be removed in less than 24 hr. and roof covering can be placed in advance of the time required on concrete slabs.

C. The material, being a nonconductor, decreases heat losses through roof, reduces coal consumption required for heating and is free from condensation on the under side of the slab.

D. The material has successfully passed several fire tests conducted by the Bureau of Buildings, New York City, and at the Columbia University fire-testing station at Brooklyn.

E. There was a noticeable absence of cracks on all installations inspected, which is undoubtedly due to the elasticity of the material.

F. The cost of maintenance and repair is low. The slabs are easily cut out where changes and construction are necessary; nails can be driven in the slab at any time.

This construction has the disadvantage that it is impracticable for the contractors to obtain wood chips which are free from oak and chestnut; and where these occur in the wood filler, brown stains are developed on the under side of the slab. Asbestos filler has been used in an effort to avoid this stain, but asbestos has been found unfit because of a chemical action which takes place which results in a white salt developing on the under side of the slab, which is more objectionable than the stain for the average installation. The slab is very porous, absorbs moisture freely, and when used for roofs must be waterproofed. The compressive strength of gypsum is diminished by being wet, but it regains its strength in large part when redried. It is not considered that the decrease in strength of the slab when wet is sufficient to materially affect the strength of the structure when used for light loads and short spans.

The bulletin further states that letters requesting information concerning different slab installations were sent to a number of important companies and of the seven replies received all were favorable. Information was particularly requested as to the length of time the system had been used, whether any trouble had been experienced with cracks due to irregular loading of vibration, as to any deterioration in the slab where it had been exposed to moisture or rain, as to the effectiveness of the slab in decreasing heat losses and in preventing condensation, and as to whether the installation had been entirely satisfactory.

A well known system of gypsum slab construction consists of steel cables placed in tension in the form of suspension members over I-beam supports, the whole embedded in a slab of mixed gypsum and wood chips. A slab of this type, known as the Metropolitan System, was tested by the bureau. The bulletin states that the method used by one of the companies manufacturing such a system in figuring the strength of the slab is not approved, although it appears to be safe for ordinary installations. It is believed that a method of analysis similar to that used for reinforced-concrete construction would give results that would conform more nearly to those which actually occur in the installation. Calculation on the latter basis for a roof of spans and loading as specified for the structural shop showed that the slab should be 4 in. thick instead of 3½ in. thick, as recommended by the manufacturer.

It is also believed that a change in the system of tying down reinforcing cables would result in a material improvement in the construction.

Final conclusions in the bulletin are as follows: Gypsum-composition slabs are recommended for roof construction such as will be needed for the structural shop at Norfolk and also for light floor construction where no concentrated loads occur. Gypsum slabs are not recommended for floors having heavy concentrated loads or for large spans—that is, 8 ft. or over in width—nor for office floors or roofs where stains on the under side would form a serious objection.

The loading test made by the United States Bureau of Standards is given in complete detail in the bulletin, but is too lengthy to abstract here.

Discussion of the American Society's Road Committee Report

The annual discussion on road materials and construction, under the auspices of a special committee (now of seven years' standing) of the American Society of Civil Engineers, was held in New York City, Jan. 19. This seems to have become the occasion of a kind of "indoor sport," which consists of shooting holes in each successive report of the committee.

The task the committee has undertaken is admittedly no sinecure. It has expanded from that set before the special committee in 1909 of reporting on "bituminous materials for road construction and on standards for their test and use" to one which evidently includes a definition of principles (and in some instances specifications) governing all road and pavement construction. The committee's excuse for going into the "general principles concerning materials and their use" is that "a neglect of their proper consideration is often to be found" and the committee "recommends that the neglect of these considerations be not allowed by any one to occur in any case"—whatever that may mean.

The report undertakes to fix maximum grades for various kinds of paving. The criticism of these was that 12% was too high for gravel and broken stone, due to damage from wash, that 6% was too low for bituminous surfaces, 5% too low for sheet asphalt, 8% too low for concrete, 6% too low for brick with grout filler, and 4% too high for wood block. A large part of the criticism of course came from those who were interested in promoting some one of these varieties of pavement. The table of thicknesses of pavement and foundation was criticized as giving figures 30% less than corresponding European practice.

In the section on bituminous pavements, the statement of the committee that "whenever comprehensive specifications are to be prepared, so as to permit a variety of types of bituminous materials, separate specifications, as may be necessary, should be prepared for each case," was on the whole commended as entirely justifiable with our present knowledge of bitumens. The option of using a certain brand of material under this specification, however, should be with the contractor and not with the party awarding the contract, which avoids the abuse which has been made of so-called alternate specifications.

As was to be expected, there was a large amount of difference in the opinions expressed in regard to bituminous macadam and bituminous concrete pavements. One gallon of bituminous material per sq.yd. per inch in thickness of top course in penetration work was held by many to be an excessive amount. The statement was made by several speakers that pavements were more often spoiled by use of too much bitumen than by too little. The necessity of using stone larger than 3/4 in. (as recommended in the report) for the covering material was emphasized where it was necessary to use the softer varieties of rock.

The discussion of sheet-asphalt pavement was chiefly in regard to the necessity of a binder course. It was developed that in Omaha, Neb., and Wilmington, Del., asphalt pavements have been laid without binder courses, using a 50 to 55 penetration asphalt. In Omaha there has been some creeping of the wearing surface of these pavements under heavy traffic, but the Wilmington experience was said to be without detrimental results. The committee's recommendation that "in cases where sheet asphalt is constructed next to the curb, it is advisable to coat the surface for a space of 12 in. next the curb with hot asphaltic cement" was said by Clifford Richardson to be an obsolete practice.

Concrete pavements were somewhat scantily treated in the report and the general sentiment seemed to be expressed by Samuel Whinery when he said that "every one would be disappointed in the amount of information it contained, that nothing was said about one- or two-course pavements or about the application of bituminous surfacing." Various individual items were criticized by A. N. Johnson, of the Portland Cement Association, who said that the report did not bring out the proper methods of finishing. He said that some method of compressing the wet concrete in place, and removing the excess water, as by use of heavy plank floats at Sioux City, Iowa (see *Engineering News*, July 29, 1916) and by use of wood rollers at Macon, Ga. (and Charlotte, N. C., as described in *Engineering News*, Oct. 26, 1916), was necessary to obtain the best results.

The question of sand-cushion or monolithic type of construction for brick pavements was again discussed, and the report's contention that a desirable cushioning effect was secured by a bedding of 1 in. of sand was upheld by Prevost Hubbard, of the United States Office of Public Roads and Rural Engineering, who said that tests made in the laboratory at Washington showed that the sand gave a decided cushioning effect under impact, and that a brick and 5-in. monolithic foundation broke under exactly the same impact as a brick with a 1-in. cushion between it and the 5-in. foundation, which apparently disproved the theory that thinner foundations with the monolithic type of construction are justified.

The part of the report on wood-block pavement was criticized chiefly as being too specific. This part is made up of the specifications drawn by a joint committee of the various engineering societies which met in Brooklyn, N. Y., last fall, and differs from the greater part of the American Society of Civil Engineers' committee report in being specific in details. Since every other engineering society either has or will soon adopt these wood-block specifications, it was evidently considered safe to include them in the progress report.

Since the joint committee adopted these specifications it has been discovered that the recommended, or rather suggested, steam treatment before the final or supplemental vacuum, is a patented process. It was stated, however, that the patent could be side-stepped by doing the steaming after the final vacuum instead of before.

News of the Engineering World

Proposed New Jersey Highway Reform

At the recent close of his term of office, Governor Fielder of New Jersey, transmitted to the legislature the report of the commission appointed to investigate the matter of improved highways and to formulate a road policy for the state (see *Engineering News*, July 27, 1916). The same legislature provided a bond issue of $7,000,000, which was approved by popular vote in the November election, but has since been held to be illegal by the state attorney general.

The special commission recommends a highway commission of three members, appointed by the governor with the consent of the state senate. The commissioners would receive $25 for each meeting attended, not to exceed $1000 per year, their terms to be for six years, with the power of removal by the governor. Full responsibility and authority for the selection of routes for the state highway system would be vested in this board.

It is recommended that there be a state highway department composed of the state highway commission, the county boards of freeholders and the governing bodies of incorporated municipalities of over 2500 population. This department would be subdivided into a state branch, county branches and municipal branches, each branch having its own engineering bureau.

The chief officers of the state highway department would be a state highway engineer (salary not to exceed $10,000), a secretary of the commission (salary not to exceed $5000), and such assistant state highway engineers (at $5000 or less) as might be necessary. The present county engineers would be continued in direct charge of the engineering bureaus of the county branches and eventually be placed under civil service. The municipal branches would be under the city engineers. This plan would make county and city engineers state officers, so far as their road work is concerned. They would be under the general supervision of the state highway engineer; as to street pavements, this supervision would be limited to such of these highways as form connections with the general system and would not involve the state's assuming complete control. The purpose is to assure such connections through densely populated districts as are required for through traffic, by means of help extended to the governing bodies in charge and by supervision of the work on such connecting streets. The report recommends that the proposed state highway commission be empowered to fix certain minimum requirements, such as width of roadway, width of pavement, thickness of foundation and pavement, type of surfacing, etc.

The special commission adopted 1250 mi. of highway for a principal or state system, 1250 mi. for "feeder" highways, and 1250 mi. of branch highways, as a basis of the system to be improved. It is proposed to construct the 1250 mi. of main or trunk lines in the five years 1917-1922. The estimated cost is $25,000,000, of which $888,000 would come from the Federal Government, $3,500,000 from general state appropriations, and $9,660,000 from motor vehicle fees, making a total of $14,048,000. The balance would be raised by a state tax of $1 per $1000 per year for five years, which it is estimated would yield $14,000,000, making a grand total of $28,000,000. Of this the extra $3,000,000 would be used for maintenance and upkeep.

Indiana Engineers Reminisce

Historic and romantic aspects of the engineering profession were brought out at the 37th annual meeting of the Indiana Engineering Society, which was held Jan. 18-20 at Purdue University, Lafayette, Ind.

The important relation of the work of the old-time pioneer surveyor to the development of the country is not often realized, but was set forth in a convincing and interesting manner in a paper by George R. Wilson on "The Vincennes Tract and the Freeman Survey." The Vincennes tract was an area (in what is now southern Indiana) granted by the Indians to the French some 200 years ago; this was taken from the French by the British, and eventually taken from the latter by the Americans under General Harrison. It was inaccessible to the "white man" except by crossing Indian lands, but General Harrison secured a further grant extending to the Ohio River, then one of the great routes of the settlers and pioneers.

Mr. Freeman was the surveyor employed by the United States Government to run the boundaries of this tract of land, about 1790. The lines are still known as "the Freeman survey." This, of course, was long before the State of Indiana was established. These lines have been retraced in recent years, and found to be very accurate, and there is a movement to perpetuate the monuments in order to mark an historical development of the country.

Following this paper a talk on "Reminiscences of an Indianian" was given by Gen. Anson Mills, U. S. A., who graduated from West Point in 1857. He was a surveyor and engineer in early days in Indiana and Texas, and more recently a member of the Mexican Boundary Survey Commission. He gave many examples of the work, the difficulties and the enterprise of the pioneers of his own youthful days. In concluding his address he pointed out the resourcefulness and self-help of these men (and women too) under the spur of necessity, and he urged a return to such conditions under modern aspects. His idea is to establish a county community having water-supply, sewerage, electric light and power, and modern conveniences, where farm work and manufacture can go hand in hand. He asked the assistance of the Indiana Engineering Society in this work, and offered $5000 to the first county which will raise $45,000 in addition for establishing and equipping such a community. It is of interest to note here that a few years ago General Mills gave to his home town a memorial to his mother and father in the shape of a water-works system, a gift of more practical and permanent value than a marble monument.

In a paper on "Human Engineering," by E. B. Smith, reference was also made to the difference between the early conditions when each family was largely a self-sustaining unit, and the modern conditions where in a large factory a man may do nothing but some one minor detail in the process of manufacture. This paper dealt more particularly with the modern methods of Taylor, Emerson and others in analyzing and developing the efficiency of human energy.

Another feature of the Indiana meeting was the amount of attention given to mechanical and electrical engineering, since the State engineering societies as a rule devote their attention mainly to civil engineering. The President, Prof. L. W. Wallace, stated that the Society aimed to cover these three branches of the profession. The program included papers on locomotive design, the organization of manufacturing plants, street lighting, and loss of power in belts and pulleys of power-transmission systems. This aspect of the meeting was emphasized by a joint session of the Indiana Engineering Association and the Indianapolis-Lafayette sections of the American Society of Mechanical Engineers and American Institute of Electrical Engineers.

Distinctly civil engineering matters in fact were quite in the minority in the proceedings. They included a paper by J. S. Spiker (Vincennes, Ind.) on the works of the Brevoort levee and drainage district (described in *Engineering News* of Jan. 11). There were a few papers also on structural, paving and sewerage matters. Another group of subjects related to appraisal and the regulation of public-utilities. One evening was devoted to a general inspection of the engineering laboratories and shops, which were in full operation by the students. In this way the visitors obtained a good idea of the work and activities of the engineering department of the University.

Muscle Shoals, Tenn., as the Site for the Government Nitrate Plant

A delegation of prominent engineers of Tennessee, on behalf of the Engineering Association of the South, gave to President Wilson on Jan. 22 an engineer's brief to demonstrate that Muscle Shoals, on the Tennessee River, is by far the most advantageous site for the construction of the $20,000,000 nitrate plant provided for at the last session of Congress.

This engineer's brief is a far more convincing document than the usual lawyer's brief. It is a pamphlet of some 60 pages, gotten up in the most artistic style known to the printing art, replete with illustrations in color which are artistic gems, and containing also an abundance of maps and diagrams to reinforce the arguments in the text.

The engineers estimate the water power which may be developed at Muscle Shoals as 250,000 hp. and this may be doubled by providing storage reservoirs on the river above. These estimates all for 24-hour all-the-year-round power. For commercial power, working 10 hours per day, and available all the year except the dry-weather period, the power can be enormously increased.

The Muscle Shoals site is so far inland that it is well inside the safety zone established by the War College. A map of the United States showing available water-power sites in the United States inside the safety zone indicates that at no other site in the zone can so large a water power be developed.

In close proximity to the site are great deposits of limestone, coking coal and phosphate rock, furnishing the raw materials for the manufacture of either nitric acid in time of war or fertilizers in time of peace. The climate, labor supply, transportation facilities, and central location with reference to fertilizer markets are all in favor of the Muscle Shoals site. Its development, moreover, will complete the improvement of the Tennessee River for navigation and the products of the plant can be distributed by water over the entire area covered by the Mississippi and its navigable tributaries.

The Committee of the Engineering Association of the South, which has prepared this remarkable brief, has as its Chairman, John Howe Peyton; Vice-Chairman, Hunter McDonald, and Executive Secretary, Willis G. Waldo. The members of this committee who have given freely of their time and energy in the preparation of this unusual document have done so not merely because they were seeking to secure the location of a great industrial plant in their own locality, but in the belief that the Muscle Shoals site is so far superior to any other possible site for the Government nitrate plant that they are performing a patriotic duty in impressing its advantages on the Government officials responsible.

Flood-Control Works Projected for Los Angeles County, California

The citizens of Los Angeles County, California, are to vote on Feb. 2 on a bond issue of $4,600,000 for the construction of flood-control works according to plans prepared by J. W. Reagan, Engineer of the Los Angeles County Flood-Control District. In *Engineering News*, Feb. 10 and Feb. 17, 1916, were published full descriptions of the flood-control problem in Los Angeles County, prepared from the report of a special commission of engineers that was appointed immediately after the disastrous floods of February, 1914.

This commission recommended works for flood control having a total estimated cost of $16,500,000. Modified plans for flood control, involving about a quarter as great an expenditure, were later prepared by J. W. Reagan and after various amendments were finally adopted by the Board of Supervisors of the county on Jan. 2.

The plan of flood control recommended by Mr. Reagan follows along the general lines laid down by the board of engineers for flood control. It makes a larger use, however, of storage dams and adopts a comparatively inexpensive type of construction for the retaining walls to regulate the river channels. Check dams are to be built in mountain cañons and in addition the following storage dams: On Pacoima Wash, a concrete dam 145 ft. high to impound 3200 acre-feet of water; at the Devil's Gate site on the Arroyo Seco, a concrete masonry dam 130 ft. high to impound 6600 acre-feet of water; two miles above the mouth of San Dimas Cañon, a dam 145 ft. high to impound 2500 acre-feet of water; on the headwaters of San José creek, two earth dams 40 ft. high to store 2250 acre-feet of water. Concerning the plan for protecting the river channels, Mr. Reagan says in his report:

The type of bank protection in general will consist of either a boulder levee thrown up by steam shovel or a single

row or double row of fencing filled in between with orchard cuttings or brush and weighted down with rock.

On the Los Angeles, Rio Hondo and San Gabriel Rivers we shall build training works consisting of a double row of piling about 5 ft. apart, on the stream face of which will be placed wire fencing and the space between the piling filled with brush and rock.

To protect Los Angeles and Long Beach harbors from inflow of silt, a dike is to be built extending southeast from Dominguez Hill to deflect flood waters to the Los Angeles River at Cerritos trestle. From this trestle to the Pacific Ocean, levees will be built due south to confine the waters to a straight channel, with a slope of nearly 8 ft. per mi. This part of the protection works will absorb nearly one-fourth of the proposed total outlay.

Grade-Crossing Removal at Detroit

A special bureau for grade-crossing elimination is to be organized at Detroit, in the city engineer's office, as a result of an investigation made by the Detroit Bureau of Governmental Research and recommendations of Mayor Marks in a message to the City Council on Jan. 9. The investigations for the Bureau of Governmental Research were made by H. S. Morse, Engineer of the Bureau.

Forty-four of the grade crossings that formerly existed in Detroit have been eliminated, but there still remain 178 grade crossings to be removed. These crossings have been classified by the city engineer as follows: Very dangerous, 4; dangerous, 121; moderately dangerous, 43; well protected, 10. At 25 of these crossings street-car lines cross the steam-railway tracks. Agreements have been reached for removing 17 of these crossings.

Heretofore responsibility for initiating and forwarding the work of grade-crossing removal has been divided among various departments of the city government, the state railroad commission and the railroad companies. The new bureau will be organized by assigning an assistant engineer from the city engineer's office, who will be in charge of the bureau; and the services of a consulting engineer will also be at his disposal to assist in carrying out the work. Under the plan previously adopted for removal of grade crossings the entire construction cost is borne by the railway company, and the city bears the cost of damages to abutting property. A rough estimate indicates that the cost of eliminating the grade crossings still in use will be about $14,000,000 for construction alone, not including damages to abutting property.

Engineering Contractors Meet

At the annual meeting of the American Society of Engineering Contractors in New York City on the night of Jan. 19, the following officers were elected: President, John T. Harrop; vice-presidents, John B. Goldsborough and Oliver O. Lefebvre; directors, A. S. Kelley, Warren Wood and William H. Hyde.

Stress was laid by H. L. Cole on the necessity for careful reading of specifications and contracts. He was of the opinion that a contractor should be paid $5 for every day the contract was finished ahead of schedule, and believed that a clause to that effect should be inserted in the specifications.

It was suggested that the monthly meetings of the society be called "Smokers"—a name calculated to increase the attendance. Meetings will be held on the second Thursday of each month. The banquet was held on the following night at the Marlborough Hotel. The first after-dinner entertainer was Edward Wegmann, who reminisced of engineers and contractors he had known in his forty years' practice. Motion pictures were then shown of the construction of the Keokuk dam.

The Milton River-Regulating Reservoir on the Mahoning River a short distance west of Youngstown, Ohio, filled nearly to the top recently. In the wet weather of the last few weeks the dam filled to within 8 ft. of the spillway crest. The city officials of Youngstown were not desirous of letting the reservoir fill to the overflow point, but it was necessary to open all four of the discharge gates wide to hold the water down.

New Pension Rules for Retired Employees of the Pennsylvania R.R. went into effect on Jan. 1. The pension allowance paid monthly by the railroad hitherto has been 1% of the average regular monthly pay during the 10 years preceding retirement, multiplied by the number of years of the pensioner's service with the company. Under the new plan, employees who during the last 10 years of their service have been unable to make full time on account of illness or infirmity will not have their pensions reduced by reason of the reduction in the average monthly rate caused by such loss of time. There is also established a minimum pension rate of $15 per month. This revised rule will apply to all employees hereafter pensioned and to employees hitherto pensioned, whose pensions will be increased by the adoption of this rule. The pension list on the Pennsylvania Lines east of Pittsburgh and Erie now contains 3,673 names. The Pennsylvania pension bureau was established on Jan. 1, 1900; since that time 7,508 employees have been pensioned, and the amount paid out has been $10,439,000.

PERSONALS

S. D. Bacon has been appointed Division Engineer of the Texas & Pacific Ry. with office at Marshall, Tex., to succeed H. P. Mobberly, resigned.

Arthur J. Rhodes, formerly Assistant City Engineer of Manhattan, Kan., has been appointed City Engineer, succeeding the late Fred Walters.

F. von Sprecken, Assistant Engineer of the Atlantic Coast Line R.R. at Savannah, Ga., has been promoted to be Division Engineer at Waycross, Ga.

Thomas C. Desmond, Assoc. M. Am. Soc. C. E., has been elected President of T. C. Desmond & Co. (Inc.), Engineers and Contractors, New York City.

R. C. Nagle has resigned as Designing Engineer for Albert Kahn, Architect, Detroit, Mich., to go to Japan for the Trussed Concrete Steel Co., of Youngstown, Ohio.

Edward T. Jeffery has resigned as Chairman of the Board of Directors of the Denver & Rio Grande R.R. after having been associated with this railway since 1891.

Albert T. Canfield has resigned as Building Engineer of the Kansas City Stock Yards Co., Kansas City, Mo., to go with the engineering department of the Union Pacific R.R. at Omaha, Neb.

John E. Williams, County Surveyor of Pottawatomie County, Kansas, has been appointed County Engineer of Shawnee County, with headquarters at Topeka, Kan., succeeding Walter Arnold.

Joseph E. Kuhn, Brigadier-General, U. S. A., who was recently promoted from the rank of Colonel in the Corps of Engineers, has been made President of the War College and Assistant to the Chief of Staff.

Malcolm Parlin has been appointed County Engineer of Leavenworth County, Kansas, with office at Leavenworth. He is a graduate of the University of Kansas and was recently Assistant City Engineer of Leavenworth.

F. S. Nicholson, for the past eight years Vice-President and General Manager of the Sayre Electric Co., Sayre, Penn., has been elected Vice-President and General Manager of the Rutland (Vt.) Railway, Light and Power Co., succeeding Byron T. Burt, resigned.

J. W. Stewart, of Foley, Welch & Stewart, railway contractors, of Vancouver, B. C., is now in charge of railway con-

struction for the Allies on the western front in France. He is a Colonel in command of several Canadian battalions which have been organized into a railway construction corps for service in France.

Eliot Wadsworth has retired from the firm of Stone & Webster, Boston, Mass., to become Acting Chairman of the Central Committee of the American Red Cross, with headquarters at Washington, D. C. He is a graduate of Harvard University and has been active in the management of the Stone & Webster properties since 1898.

Carl M. Hansen, M. Am. Soc. M. E., former Secretary and Chief Engineer of the Workmen's Compensation Service Bureau, New York City, now Managing Director of the Pennsylvania Mutual Liability Association, Philadelphia, Penn., has been made Chairman of the Committee for Accident Prevention and Workmen's Compensation of the National Association of Manufacturers.

Frederick R. Harris, M. Am. Soc. C. E., Civil Engineer, U. S. N., and Chief of the Bureau of Yards and Docks, has been named by the President as Rear-Admiral, under the new law which provides for five staff officers of the navy with the rank of Rear-Admiral. His list rank was Lieutenant-Commander, but he has had an ex-officio rank of Rear-Admiral by virtue of his position as Chief of Bureau.

David W. Taylor, Chief Naval Constructor, U. S. N., and Chief of the Bureau of Construction and Repairs, has been named by the President and confirmed by the Senate as Rear-Admiral, under the new law which provides for five staff officers of the navy with the rank of Rear-Admiral. His list rank was Captain, but he had had an ex-officio rank of Rear-Admiral by virtue of his position as Chief of Bureau.

V. H. Kreigshaber, M. Am. Soc. C. E., of Atlanta, Ga., has been appointed a member of Plaza Terminal Commission of the city, recently created by city ordinance on the suggestion of Barclay, Parsons & Klapp, Consulting Engineers, New York City. Another member of the commission is **P. H. Norcross,** M. Am. Soc. C. E., of the Solomon-Norcross Co., Consulting Engineers, Atlanta. The terminal plans recommended by Barclay, Parsons & Klapp were described in "Engineering News," Oct. 12, 1916.

Edward C. Sherman, M. Am. Soc. C. E., Consulting Engineer, Boston, Mass., has been appointed Designing Engineer in the Bureau of Yards and Docks of the Navy Department, at Washington, D. C., as a result of the nonassembled civil service examination held last December (noted in "Engineering News," Nov. 23, 1916, p. 1010). Mr. Sherman is a graduate of the Massachusetts Institute of Technology, class of 1898, and for a number of years was with the Metropolitan Water and Sewerage Board at Boston and with the Isthmian Canal Commission in Panama Canal Zone as Designing Engineer. Previous to taking up private practice he was Division Engineer of the Charles River Basin Commission, which built the Charles River dam at Boston.

Howard C. Phillips, M. Am. Soc. C. E., recently Assistant General Secretary of the Presidents' Conference Committee on Federal Valuation of the Railroads, has been appointed Secretary, succeeding Thomas W. Hulme, who has been made Vice-Chairman of the committee. He is a civil engineering graduate of Princeton University and in 1893 was Assistant Engineer on the four-tracking of the Shore Line of the New York, New Haven & Hartford R.R. Later he was on track elevation work in Boston. In 1898 he went to New Mexico on location surveys for the Pecos Valley & Northeastern R.R. He soon joined the engineering corps of the Atchison, Topeka & Santa Fe Ry. and was promoted through various grades to be Chief Engineer of the company's Coast Lines at Los Angeles in 1906. In 1912 he was made Valuation Engineer with headquarters at Chicago.

OBITUARY

William H. Hedges, one of the old-time Chicago surveyors, died at his home in that city on Jan. 16. After the great fire of 1871, when public records of land and surveys were destroyed, he gave the city free use of his own records for the public benefit.

Clarence M. Wood, County Engineer of Coffey County, Kansas, and City Engineer of Burlington, Kan., was shot and killed by an insane domestic at his home in Burlington, Jan. 14. He was graduated from Baker University in 1908 and studied civil engineering at the University of Kansas. He was formerly with M. A. Earl & Co., Muskogee, Okla.

George A. H. Mould, Assoc. M. Am. Soc. C. E., a civil engineer employed recently as Chief Estimator for C. T. Wills, Inc., General Contractors, New York City, died Jan. 21 at his home in Brooklyn. He was born in Kingston, Jamaica, and his engineering experience included supervision of construction work in Egypt, South Africa and Cuba. For many years he was in charge of erection jobs for Milliken Brothers, New York. He was an associate member of the Institution of Civil Engineers of Great Britain.

Andrew Chase Cunningham, M. Am. Soc. C. E., Corps of Civil Engineers, U. S. N., committed suicide at his home in Washington, D. C., Jan. 13. He was born in New York City, Feb. 15, 1858. He was graduated from the United States Naval Academy at Annapolis in 1878. He resigned from the service in 1884. At the beginning of the Spanish-American War he was appointed Ensign for temporary service and was honorably discharged in 1898. He was appointed Civil Engineer in the Navy about the same time.

ENGINEERING SOCIETIES

NORTH DAKOTA SOCIETY OF ENGINEERS.
Jan. 30-31. Annual meeting in Bismarck. Secy., E. F. Chandler, University, N. D.

OHIO ENGINEERING SOCIETY.
Jan. 31-Feb. 2. Annual meeting. Ohio State University, Columbus, Ohio. Secy., John Laylin, Norwalk, Ohio.

OREGON SOCIETY OF ENGINEERS.
Feb. 5. Annual meeting in Portland. Secy., Orrin E. Stanley, P. O. Box 973, Portland, Ore.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

NATIONAL LIME MANUFACTURERS' ASSOCIATION.
Feb. 6-7. Annual meeting in New York City. Secy., F. K. Irvine, 537 South Dearborn St., Chicago.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 7-9. Midwinter convention in New York City. Secy., F. J. Hutchinson, 33 West 39th St., New York City.

MINNESOTA SURVEYORS' AND ENGINEERS' SOCIETY.
Feb. 7-9. Annual meeting in Minneapolis.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

AMERICAN ASSOCIATION OF ENGINEERS.
Feb. 8-10. In Chicago at the Hotel La Salle.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 14-15. Annual meeting in Indianapolis. Secy., W. F. King, Indianapolis, Ind.

WISCONSIN ENGINEERING SOCIETY.
Feb. 15-16. At Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 19-22. Meeting in New York City. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb 20-21. Annual meeting in New Haven in Mason Laboratory. Secy., J. F. Jackson, New Haven.

IOWA STATE DRAINAGE ASSOCIATION.
Feb. 20-21. Meeting in Fort Dodge. Secy., M. F. P. Costelloe, Ames.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting in Ames. Secy., J. H. Dunlap, Iowa City.

The Binghamton Engineering Society held its annual meeting and dinner on Jan. 23. The secretary is Ray W. Aldrich.

The Iowa State Drainage Association will meet in Fort Dodge, Feb 20 and 21. The secretary is M. F. P. Costelloe, Ames.

The Engineers' Club of Memphis, Tenn., on Jan. 10 elected the following officers: President, A. L. Dabney; vice-president, C. C. Pashby; secretary, T. H. Allen.

The Civil Engineers' Society of St. Paul, Minn., on Jan. 8 elected the following officers: President, P. E. Stevens; vice-president, C. E. Nagel; secretary, H. A. Gerst.

The Franklin Institute on Jan. 17 elected the following officers: President, Walton Clark; vice-president, Coleman Sellers, Jr.; treasurer, Cyrus Borgner; secretary, R. B. Owens, Philadelphia.

The Connecticut Society of Civil Engineers will hold its annual meeting Feb. 20 and 21 at the Mason Laboratory, Yale University, New Haven, Conn. The secretary is J. Frederick Jackson, New Haven.

The Springfield Engineers' Club on Jan. 15 installed the following officers: President, B. H. Peck; vice-presidents, B. G. Campbell and F. R. Atwood; treasurer, C. A. Crytser; secretary, J. R. Hughes, Springfield, Ill.

The Engineers' Club of Trenton has elected the following officers for 1917: President, Fred C. Carstarphen; vice-presidents, Henry B. Kummel and Charles R. Fairchild; treasurer, John E. Elliott; secretary, Joseph E. English.

The Cleveland Association of the American Society of Civil Engineers has elected the following officers: President, Wilbur J. Watson; vice-president, Harry Fuller, of the King Bridge Co.; secretary, George H. Tinker, bridge engineer of the Nickel Plate R.R.

The Providence Engineering Society announces section meetings in the following fields: Machine shop, chemical, efficiency and scientific management, power, municipal highway and water-supply, structural, industrial and technical education, designing and drafting. A meeting will be held each week.

The Florida Engineering Society, recently organized, has planned to hold its first annual meeting in Tampa, Feb. 2 and 3, with headquarters at the Hillshoro Hotel. The chairman of the local committee is R. D. Martin, city engineer of Tampa. The secretary of the Engineering Society is J. R. Benton, Gainesville.

The American Institute of Consulting Engineers at its annual meeting on Jan. 15 in the Engineers' Club, New York City, elected to the Council the following members: Gardner S. Williams, to serve to January, 1919; A. M. Hunt, Lewis B. Stillwell and William J. Wilgus, to serve until January, 1920. The secretary is F. A. Molitor.

The Kansas Engineering Society held its ninth annual meeting Jan. 16 and 17 in Topeka, electing H. B. Walker, president, and C. M. Buck, vice-president. The secretary is C. A. Forter, Topeka. Among the several topics discussed were the Society and its relations to electrical, mechanical and railroad engineers and to architects.

The Bridge Builders' and Structural Society at the annual meeting in New York on Jan. 12 elected the following officers: President, C. D. Marshall, of McClintic-Marshall Co., Pittsburgh; vice-president, Thomas Earle, of the Bethlehem Steel Bridge Corporation, South Bethlehem; treasurer, Harry Fuller, of the King Bridge Co.; secretary, George E. Gifford, 50 Church St., New York City.

The Engineers' Society of Western Pennsylvania at its annual meeting Jan. 16, in Pittsburgh, announced the election of the following officers: President, Alex. L. Hoerr, chief engineer, National Tube Co., McKeesport, Penn.; vice-president, George H. Neilson; treasurer, Albert E. Frost; secretary, Elmer K. Hiles, Pittsburgh. On Jan. 20 the Society held a smoker at the Fort Pitt Hotel.

American Concrete Institute—At the annual meeting at the Hotel La Salle, Chicago, Feb. 8 to 10, 1917, the main papers will be "Slag and Cinders as Aggregate," by Sanford E. Thompson; "Flow of Concrete," by the United States Office of Public Roads; "Effect of Hydrated Lime on Strength, Absorption and Expansion of Concrete," by Prof. H. H. Scofield; "A Course of Instruction in Reinforced Concrete," by Prof. W. K. Hatt, and "Effect of Width of Slab on Effective Width of Design," United States Office of Public Roads. There will be in addition the usual committee reports, prominent among which this year will be one on Standard Building Regulations for the Use of Reinforced Concrete. There is expected to be considerable discussion of this because of various provisions, particularly in the flat-slab floor section, which differ from similar ones in the recent report of the Joint Committee. An innovation of the convention will be two luncheons and round-table talks.

Western Society of Engineers—The 47th annual meeting and dinner was held at the Sherman Hotel, Chicago, on Jan. 10. The addresses included "The Engineering School and the Engineering Profession," by F. E. Turneaure, dean of the College of Engineering, University of Wisconsin, and a talk on the work of the engineer in Europe after the war, by James Keeley, editor of the "Chicago Herald." The announcement was made of the award of the Chanute Prize for the following papers: "The Currents of Lake Michigan and Their Effects on the Climate of Adjoining States," by Col. C. McD. Townsend, United States Engineers (St. Louis, Mo.); "Wind Stresses in the Steel Frames of Office Buildings," Wilbur M. Wilson, Assistant Professor of Structural Engineering, University of Illinois. On Jan. 11 there was an excursion by special train to the works of the Pullman Co. and the Illinois Steel Co. The Society now has over 1200 members. The officers elected for 1917 are as follows: President, H. J. Burt; vice-presidents, D. W. Roper, J. N. Hatch and W. W. DeBerard; treasurer, C. R. Dart. The secretary is E. N. Layfield, Chicago.

Appliances and Materials

Special Trailer Truck

A special form of trailer truck is being built by the Electric Wheel Co., of Quincy, Ill., for use in connection with the small tractors or motor trucks employed in warehouses, railway freight terminals, docks, factories, etc. The trailers are so made, with diagonal connections between the axles, that the rear wheels follow the path of the front wheels in rounding curves, and all trucks in a train will follow the path of the tractor. They will traverse curves as sharp as 6-ft. radius. The frame is of steel, with wood platform 3½x7 ft., and is mounted on four 18-in. wheels with a wheelbase of 5½ ft. The wheels may be of steel (with 3-in. flat tires or rubber tires), or they may be of wood or fiber construction if desired. A swinging coupling enables trucks to be coupled at any angle. The truck has a capacity of 2½ tons and weighs about 800 lb. with steel wheels.

* * *

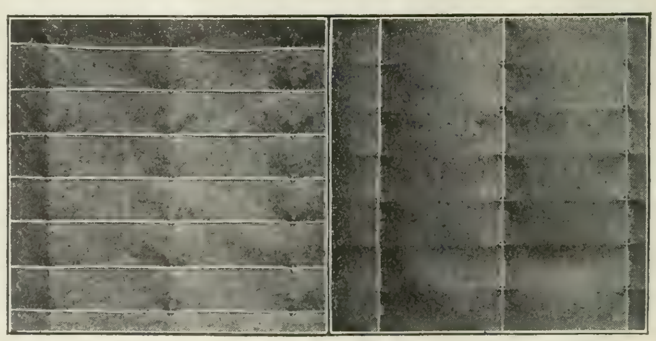
Small Alternating-Current Rectifiers

A new line of small-sized commercial rectifiers for converting alternating current to uni-directional, to be used in storage-battery charging, has been developed by the General Electric Co., of Schenectady. The rectifying element is a vacuum bulb with a tungsten filament and a graphite electrode surrounded by an inert gas—an electrical "valve" developed in this company's research laboratories. The efficiency of the rectifiers is from 30 to 75%, rising with the load. A steel casing incloses a panel or base carrying the bulb, a fuse to protect against reversal or overload, and a compensating transformer to reduce the voltage of the alternating current and to feed the bulb filament. The smallest outfit weighs 8 lb. and furnishes 2 amp. at 7 volts from a 115-volt 60-cycle circuit. The medium-sized rectifier furnishes 6 amp. at 7.5 to 15 volts and weighs 15 lb. The largest unit is for 6 amp. at 7.5 to 75 volts, having 15 taps from the compensator running to a dial switch for quick and easy adjustment of voltage.

* * *

New Metal Lathing

An entirely new lathing and light reinforcing material is now being put out by the Clinton Wire Cloth Co., of Clinton, Mass., under the trade name "welded sheathing." As shown in the accompanying view, it consists of steel wires running in opposite directions, separated for the most part by a sheet of tarred felt, but welded at intersections through small holes punched out of the felt. The longitudinal wires are No. 13 gage galvanized, spaced 3 in. apart, and are on the front or exposed side of the felt and carry the plaster or mortar. The vertical, or stay, wires are 8 in. apart, are of the same gage and are stapled to the building studs. As the plaster or mortar is applied, the felt bulges away from the horizontal wires and gives the material a chance to key all around them. The felt serves as a backing to retain the mortar and prevent waste. The material is furnished from stock in flat sheets 32 in. wide and 8 ft. long, crated in 50-sheet bundles.



CLINTON WIRE CLOTH "WELDED SHEATHING"

The cost is claimed to be about half that for all-metal lathing for the same area and service.

The material has been approved by the building bureaus of the several New York City boroughs. Two plaster partitions, one with steel and one with wood studs, were officially tested at the Columbia station and withstood a 1700° fire for one hour, followed by water from a fire hose.

This sheathing has been used for reinforcing, short light-load spans being stapled to joints and serving as the bottom form.

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Concrete-Mixer Boat for Ohio River Locks

By A. W. Kreamer* and Gregory M. Dexter†

In connection with the improvement of the Ohio River with locks and dams by the United States Government, the Wheeling district of the United States Engineer Department is building some of the work with hired labor. This fact necessitated the design of a plant for the mixing and handling of concrete and the concrete-mixer boat described in this article resulted.

Fig. 2 shows a typical layout of a lock and dam in the Wheeling district. The concrete yardage involved will vary from 50,000 to 100,000. This amount in conjunction with the T shape of the lock and dam, the necessity of maintaining navigation and an available net working period each year of from five to seven months has resulted in the experience that three to four years are needed to complete the masonry, although in some cases two have been sufficient.

The following methods have been used for mixing and handling concrete on the Ohio River work in the Wheeling district:

1. Mixing Plant Upon the Shore—With cableway.

2. Mixing Plants Upon or Just Inside the Coffer-dams—(a) With narrow-gage tracks leading to derricks that deposit the concrete in the forms; (b) with narrow-gage tracks upon the top of the forms, permitting the dumping of the concrete directly into place; (c) with platforms along which buggies are pushed by laborers to the forms and dumped; (d) with chutes from mixer to forms (where the forms were too high or too distant to be reached easily with the chute, there was a hoist tower at the mixer).

3. Mixing Plant Upon a Boat—(a) With hoist tower and chutes supported by cables; (b) with hoist tower and boom so that cables were not necessary to support chutes.

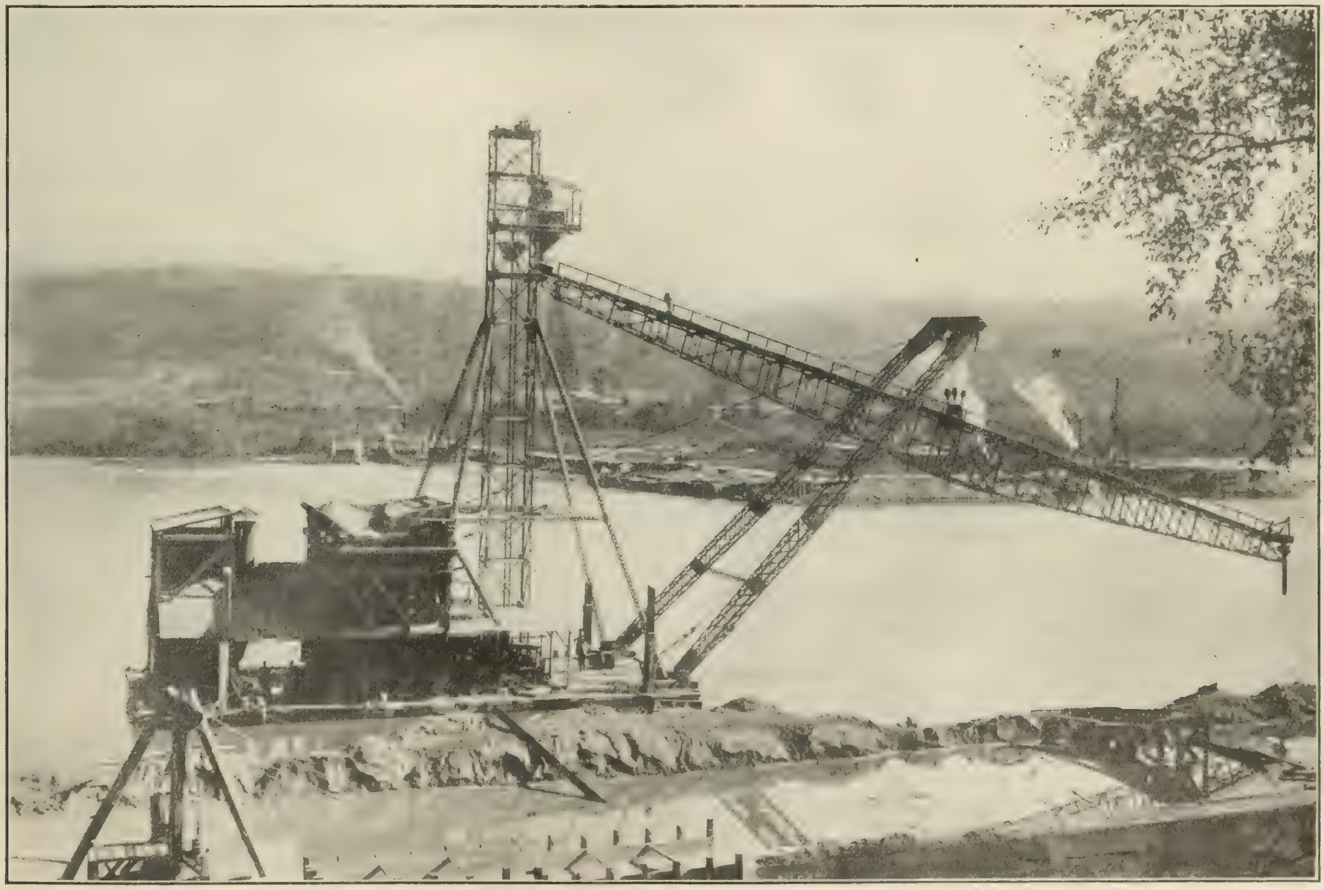

FIG. 1. VIEW OF CONCRETE-MIXER BOAT ALONGSIDE COFFER-DAM ON OHIO RIVER LOCK

Boom shown 163 ft. can be lengthened to 200 ft. A-frame 84 ft. high can be raised to 98 ft. Hoist tower 95 ft., maximum 105 ft. Note stiff-legs to hoist tower and that side of gravel bin has not been closed up

The decision to build a concrete-mixer boat with hoist tower and boom was based upon certain arguments among

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which may be mentioned the following: Concrete materials can be placed aboard a mixer boat as economically as in a mixing plant on a coffer-dam. The latter has to be dismantled and rebuilt for each coffer-dam, while with a mixer boat more elaborate construction is justifiable. The additional investment necessary to provide for boom and supporting A-frame as well as a conveyor system for handling cement bags is small after the mixer boat has been designed to carry bins, machinery and hoist tower. Much miscellaneous equipment is eliminated from the coffer-dam by the mixer boat, which gives more space or permits a smaller coffer-dam and helps when pumping out after high water. During the season of 1915 a rental of $35 per day was paid for a mixer boat, but without boom and

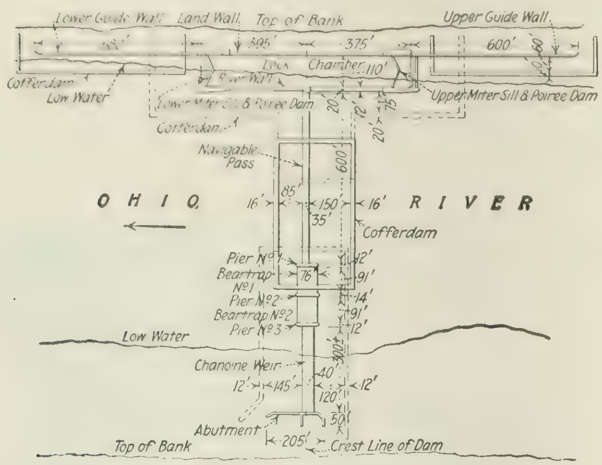


FIG. 2. TYPICAL LOCK AND DAM ON OHIO RIVER

A-frame. For the Government work a mixer boat would be used on the construction of more than one dam. Finally, the behavior of a similar but smaller boat, which had been built by the T. A. Gillespie Co., had shown its advantages.

It was not possible to delay the design and building of the mixer-boat hull until the loads it would have to carry had been determined. It was known that the mixer boat of the T. A. Gillespie Co. had a hull 32 ft. wide by 80 ft. long and about 5 ft. deep. The loads on it included a steel boom 158 ft. long, a wooden A-frame and hoist tower and one concrete mixer with the usual machinery, bins, etc. In operation the forward end of this boat was frequently level with the water surface, indicating that there was a small margin of stability for additional loads. Accordingly, the dimensions of the proposed mixer-boat hull were rather arbitrarily placed at 40 ft. wide by 90 ft. long and 6 ft. 9 in. deep at the gunwales.

Conditions Controllng Design

Later, the design of the bins, boom, etc., was undertaken. A congested steel market, the low cost of the mixer boat and pressure of other work left little opportunity for comparative designs. Some rather arbitrary assumptions were made, and a statement of these and the limiting conditions encountered follows:

From a study of the two positions in Fig. 3 the boom was designed for a range in slope from 1 on $2\frac{1}{2}$ to 1 on 4, and erection in lengths of 163 ft., 180 ft. and 200 ft., with the connection to the hoist tower at the heights shown. It was recognized that at extreme low water it might be necessary, in filling the upper portion of the land wall form, to discharge the concrete from the boom into buckets that would be lifted and dumped by a traveling derrick. Stability considerations, the frequency of extreme low water and the yardage involved were sufficient to justify the heights adopted. The boom was designed for support near its center by cables that would be approximately vertical. The distance back to the hoist tower was tentatively placed at 25 ft., and later this was found to work in satisfactorily with the location of the bins. These considerations determined the maximum and minimum lengths of the A-frame as 98 ft. and 84 ft. respectively, as well as its angle with the horizontal.

No provisions were made for quick shifts of connections in the boom, hoist tower and A-frame, as the masonry in a large coffer-dam requires about a season to complete. The A-frame head was made 15 ft. long in order that sway cables could be run from each end to the top chords of the boom. Removable crossbracing was provided in the plane of the legs of the A-frame. The depth of the boom was rather arbitrarily placed at 10 ft. The Insley Manufacturing Co.'s roller hoist bucket of 36 cu.ft. capacity was selected, owing to its low overall height and the consequent lowering of the center of gravity of the bins. The width of the hoist tower was determined by that of the bucket. The width of the boom was made about the same as the tower, which gave a simple connection to the tower as well as made satisfactory use of $2\frac{1}{2}$x$2\frac{1}{2}$x$\frac{1}{4}$-in. angles for wind bracing in the boom. The

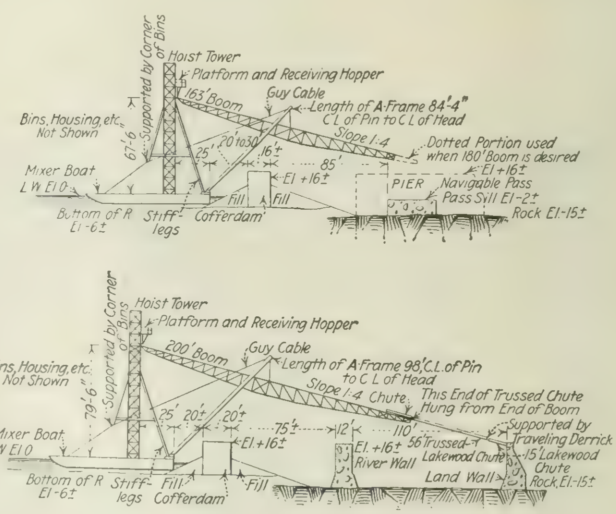


FIG. 3. OUTLINES OF MIXER WITH (ABOVE) SHORT AND WITH (BELOW) LONG DELIVERY

depth of the hoist tower was made 8 ft., and stiff-legs were provided for bracing instead of guy cables.

It was decided to make use of two right-hand $1\frac{1}{4}$-cu.yd. Smith mixers that were on hand, although one right and one left of another type would have lowered the center of gravity of the bins. Their arrangement relative to each other and the hoist tower was determined by the slope of chute to bucket and the flow of the concrete without changes in direction. It was decided to use a derrick boat with 80-ft. trussed boom, located alongside the mixer boat, for filling the bins. These decisions limited the height and location of the sand and gravel bins. For ballast purposes the coal bin and boilers were placed at the aft end of the boat.

The boom was designed for three loadings:

1. Concentrated load of 5000 lb. at the lower end and its own dead weight, using the customary unit stresses.

2. Twenty pounds per square foot of wind pressure broadside on and its own dead weight, using unit stresses 33% in excess of normal.

3. Its dead weight as a beam supported near each end, using unit stresses 33% in excess of normal.

The preceding embraces most of the important conditions or assumptions that controlled the design of the mixer boat. A general description of the boat as equipped and operated follows.

Details of Equipment of Plant

The following machinery was provided: Two 80-hp. boilers of the return-tubular type; one horizontal duplex service pump for general water-supply purposes, size 9x5¼x10 in.; one horizontal duplex feed-water pump, size 5½x3¾x5 in.; one 100-hp. feed-water heater; one 2-cylinder 12x12-in. two-drum hoisting engine for hoist bucket and boom; one 20-hp. two-cylinder winch engine for cement conveyor and spuds; five steam siphons; two 1¼-cu.yd. mixers, each driven by a vertical 8-hp. engine; one chain conveyor with wooden cleats; and one chain conveyor with curved-arm carriers.

A water line for washing out the chute on the boom, as well as steam lines for heating the chute, concrete materials, etc., has been provided. The method of filling the bins necessitated a low smokestack, but this was offset by a steam connection for forced draft. The water for each mixer is supplied through a 2-in. Trident water meter, a quick-closing gate valve and a pump operating against a relief valve. The meter dial is graduated from 0 to 100 gal., and the pointer can be set back to zero quickly.

A special measuring hopper on each mixer, with slopes ranging from 12 on 6 to the vertical, an outlet 12x18 in. and separate compartments for the sand and gravel, prevents any delay from the sticking or arching action of the aggregate.

Bags of cement are brought to the mixer boat on a covered scow that has a capacity of 3500, are carried from the scow by a cleated chain conveyor and elevated by a curved-arm carrier to a platform above the mixers and 6 in. below the tops of two cement hoppers, into which they are emptied. This platform provides storage for 200 bags as insurance against conveyor delays. The lever that controls the flow of the aggregate into the mixer controls the cement also. The cleated chain conveyor may be rotated about its driveshaft into the nearly vertical position.

The concrete spilled about the boat at the end of an 8-hr. run does not exceed ⅓ cu.yd., due to a tilting chute, the vertical travel of the bucket, the use of 1-yd. batches in a bucket whose capacity is 36 cu.ft., and a 2½-ft. bulkhead about the top of the receiving hopper on all except the tower side. Also, the tilting chute permits greater acceleration of the hoist-bucket speed by providing vertical travel and making it unnecessary to wait until all the material from the mixers has entered the bucket. The lower end of the hoist tower is in a watertight well with a removable and easily replaced bottom that would be knocked out by a falling bucket. Just above the receiving hopper are two parallel timbers that extend horizontally through the tower from the forward to the aft side, while horizontally against the forward side is another timber. Against these the bail and sides of the bucket hit when it is dumped, and thus enable the hoisting engineer to clean the bucket of concrete without assistance. The two parallel timbers prevent, also, the

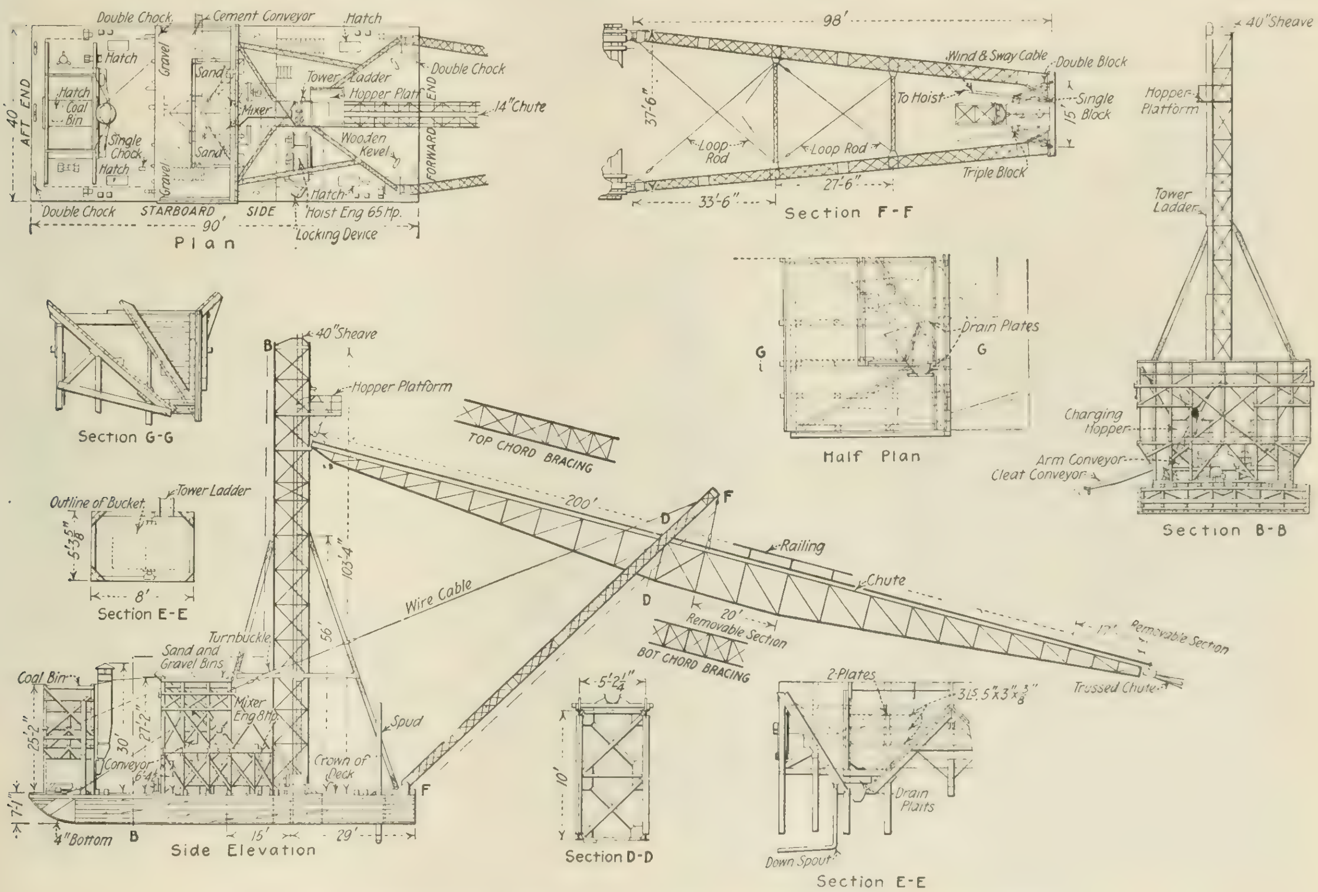


FIG. 1. DETAILS OF THE OHIO RIVER FLOATING CONCRETE PLANT

bucket from being carried too high. An automatic locking device upon the boom cable, consisting of a brake and sheave and working upon the principle of the toggle joint, takes the boom load from the hoisting engine.

The coal bin has a capacity of 60 tons, a flaring top, a sloping removable roof and is lined with No. 13 United States Standard sheet steel. Under each boiler are an ashpit and well.

As an assistance in maneuvering and holding the mixer boat it is provided with four hickory spuds 11x11 in. by 32 ft. They are operated by lines from the nigger heads on the conveyor engine, are equipped with flattened cast-iron points and bear on cast-iron rollers.

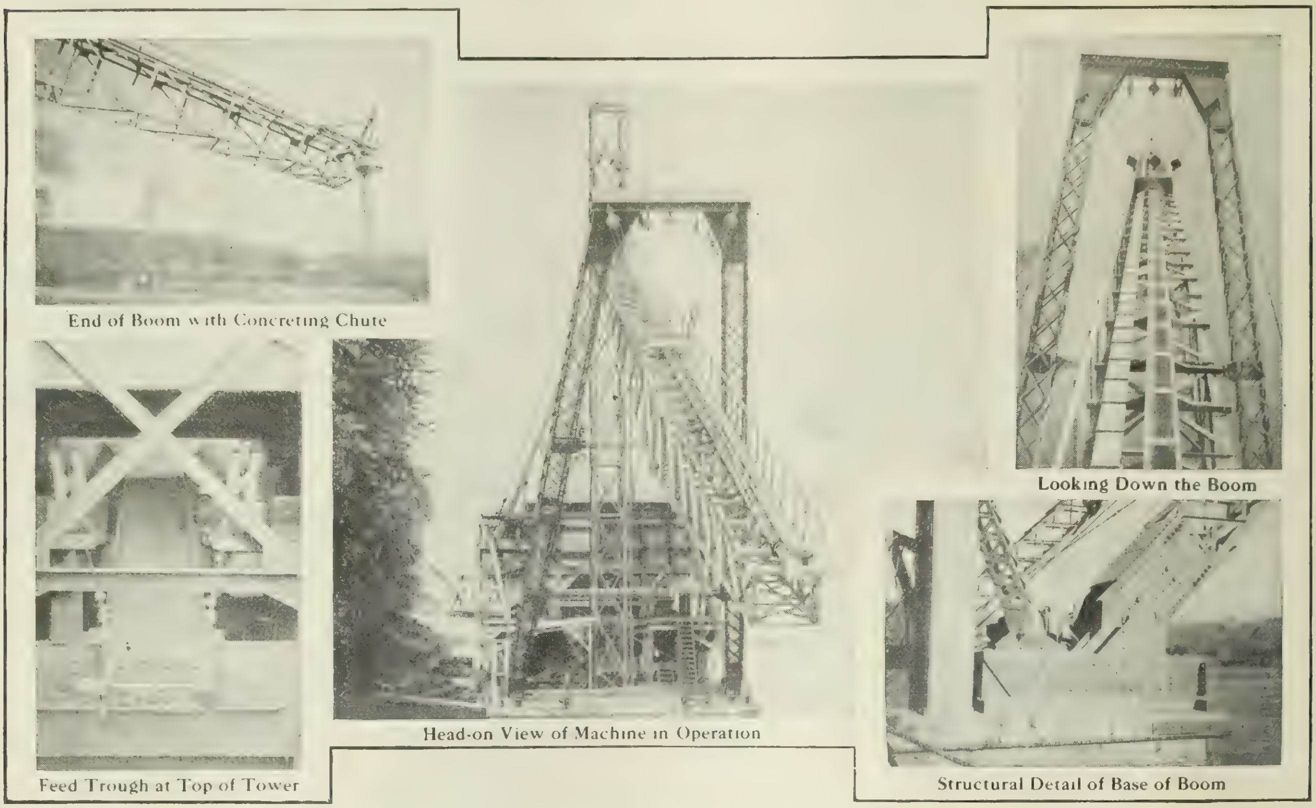
There are two sand and two gravel bins. All are lined with No. 13 United States Standard sheet steel are provided with drain plates and have side slopes ranging from the vertical to 12 on 8. Each sand bin has a capacity of 570 and each gravel bin of 1030 cu.ft. Roughly, all the bins may be described as inverted hollow pyramids. The sand bins—the smaller pyramids—are built within the larger pyramids, or gravel bins, in such a way that both have the same forward face. The inverted-V bulkhead that divides the two gravel bins from each other serves the same purpose for the sand bins. Thus, the aft and outside corner of each sand bin is supported upon the gravel-bin beams by a wrought-iron pipe column. As a result the "booming" by the derrick boat-operator is reduced to two positions, it is unnecessary to keep a boy on top of the bins to coach the operator, and the center of gravity of each bin is brought as close as possible to the center line of the boat. The latter feature reduces the amount of side listing of the mixer boat due to unequal loading of the bins.

Estimates of the stability of the mixer boat which were made when the designs had progressed sufficiently to permit indicated that the margin of stability against overturning in a broadside windstorm was not as high as might be desired. However, there were not sufficient reasons to justify any revision in loading in view of the prior design and completion of the hull. Table 1 on p. 173 shows the results of the final estimates of stability.

The mixer-boat hull has 4-in. bottom planking, 3-in. decking, 8-in. gunwales, two longitudinal bulkheads and four trusses. Transversely, there are seven trusses, at four of which there are truss rods. An estimate of the maximum bending and longitudinal shearing stresses in the gunwales and bulkheads shows values ranging from 350 to 700 and from 80 to 140 lb. per sq.in. respectively for the various loadings.

The methods followed in erecting the steel on the mixer boat have no interest except as regards the A-frame and boom. The upper portion of the A-frame was erected on sloping cribwork on the river bank; the lower portion was put in place on the mixer boat and guyed at the proper angle. Then the mixer boat was run bow on against the bank, and the two portions were joined. That half of the boom which after erection may be described as the lower portion was put together on light falsework about 25 ft. above the water surface. The upper portion was built out from the lower as a cantilever. Then the mixer boat was placed so that the legs of the A-frame straddled the boom, and the latter was hoisted into place.

In operation at full capacity 11 men are needed on the mixer boat, as follows: One foreman, one fireman, one laborer on the cement platform at the receiving end of the conveyor, one laborer at each of the two cement hoppers, one laborer at each of the two aggregate hoppers, one laborer who dumps the mixers, one hoisting engineer, one laborer at the receiving hopper on the hoist tower and one oiler. In addition a watchman is employed.



End of Boom with Concreting Chute

Looking Down the Boom

Head-on View of Machine in Operation

Feed Trough at Top of Tower

Structural Detail of Base of Boom

FIG. 5. DETAIL VIEWS OF THE OHIO RIVER LOCK AND DAM CONCRETE-MIXER BOAT

Besides the men engaged directly on the mixer boat the following men are necessary to provide sand, gravel and cement: Cement scow, four; derrick boat, two; sand and gravel digger, four; towboat, two. An additional group of men are needed to load the cement scows from freight cars, but the number varies with local conditions.

TABLE 1. DRAFT, METACENTRIC HEIGHT AND ALLOWABLE WIND PRESSURE ON MIXER BOAT

Description of Loading Mixer Boat		Maximum loading; bins full and 100 lb. of concrete per lin.ft. on boom and trussed chute	Minimum loading; bins empty and no concrete on boom or trussed chute	Maximum probable working loading; bins full and 5,000 lb. concentrated load on end of boom	Probable average working loading; bins half full and 5,000 lb. concentrated load on end of boom	Maximum waiting loading; bins full and no load on boom	Probable loading when moving boat; bins half full and no load on boom	Probable loading during erection; bins empty and no load on boom
200 ft. boom	Draft in ft. at forward end	5.5	4.5	4.8	4.8	4.2	4.3	4.4
	Draft in ft. at aft end	4.9	1.9	5.5	3.6	5.8	3.8	1.9
	Metacentric height in ft.	6.5	27.5	7.5	15.0	9.0	17.0	28.0
180 ft. boom	Draft in ft. at forward end	5.2	4.3	4.6	4.6	4.0	4.2	4.3
	Draft in ft. at aft end	5.2	2.0	5.7	3.7	5.9	4.0	2.0
	Metacentric height in ft.	6.5	27.5	7.5	15.0	9.0	17.0	28.0
163 ft. boom	Draft in ft. at forward end	4.8	4.1	4.3	4.4	3.9	4.0	4.1
	Draft in ft. at aft end	5.4	2.1	5.8	3.9	6.0	4.1	2.2
	Metacentric height in ft.	7.5	29.0	8.5	16.0	10.0	18.0	29.5
Allowable side wind pressure in lb. per sq.ft. with lowest point on gunwales at surface of water	200 ft. boom	3.5	15.0	4.0	10.0	3.5	13.0	16.0
	180 ft. boom	4.5	17.0	4.0	11.0	3.5	14.5	17.5

Under the district regulations as to the amount and rate of mixing concrete the mixer boat has no difficulty in maintaining an output of 60 batches of 1 cu.yd. each per hour. By disregarding these regulations an experimental run has shown that this could be increased to 80 batches and with a little pressure could be kept as high as 100.

Operations on the mixer boat, connected with the mixing of concrete, consumed in seconds, when the output was 60 batches per hour, the following average times: Filling sand hopper, 15 to 20 (this could be reduced materially by increasing the size of the outlet from 8½x12 in. and placing it at the bottom of the bin instead of on the side); filling gravel hopper (outlet 12x16 in.), 3 to 5; discharging sand and gravel hopper (outlet 12x18 in.), 20; emptying and filling sand and gravel hopper, adding water to mix, keeping tally on batch number (one complete operation), 60; dumping mixer, 15; returning mixer to upright position, 10; filling hoist bucket from the instant of starting to dump mixer, 20; hoisting bucket and dumping (without haste), 15; lowering bucket and placing ready for concrete, 7; receiving cement bag from conveyor, hauling 10 ft. to cement hopper and returning to position at head of conveyor, 3 to 5; emptying four cement bags into hopper (not including the cutting of wire tying bags), 15.

TABLE 2. MATERIAL USED IN CONSTRUCTION OF MIXER BOAT*

Item	Steel, Including Bolts, Washers, Castings, Nails, Sheaves, in Pounds	Timber, Including Oregon Fir, Yellow Pine and Oak, in Feet B.M.
Hull	32,000	91,000
Sand, gravel and coal bins	24,000	49,000
Hoist tower, with stiff-legs and platform	36,000	200
A-frame, shoe and struts	63,000	
Boom, with chute and yoke	36,000	1,200
Sand, gravel and cement hoppers and miscellaneous details	11,000	.....

* In addition there was about 7,500 lb. of wire rope, sockets, turn-buckles, etc.; as well as 3,000 lb. of miscellaneous material, such as oakum, asbestos, paint, etc.

The mixer boat has not proved unwieldy. It has been demonstrated that a movement for about 100 ft. in a direction parallel to its longest dimension will take about 15 min., if done without assistance from another boat. It will take about 45 min. more to turn the mixer boat through an angle of about 90°, dodge a derrick with the lower end of the boom and place the boat bow on against the cofferdam ready for use. All the movements mentioned were made with lines to the nigger heads of the conveyor and hoisting engines.

The mixer boat, with the exception of the hull, was designed by the writers under the general direction of Maj. T. H. Jackson, Corps of Engineers, U. S. A.; and Guy B. Bebout, Assistant Engineer, Wheeling, W. Va. The steel for the boom, A-frame, hoist tower and stiff-legs was fabricated by the Terry & Tench Co., Inc., New York City. Other miscellaneous steel was fabricated by the Penn Bridge Co. The boat was built under the general direction of George C. Ross, Assistant Engineer, with R. I. Stewart as foreman in direct charge.

Gypsum Filler for Concrete Floors

A type of floor construction employed recently in some large buildings consists of a reinforced-concrete T-beam slab with gypsum filler tiles in the spaces between the beams or ribs. These tiles are hollow boxes, closed on all sides, the solid ends tending to reduce loss of concrete at the joints when the concrete is poured. The bottom makes a good surface for the interior plastering. The tiles are 24 in. long, 19 in. wide and 7 to 13 in. deep, being made 1 in. deeper than the concrete ribs. The thickness is ¾ in. for the top and bottom and 1 in. for the sides, with a sheet of steel reinforcement extending entirely around the tile. The weight is 24 and 33 lb. per lin.ft. for the 7-in. and 13-in. tiles respectively.

FLOOR WITH GYPSUM TILES READY FOR CONCRETING AT THE CASTLE HOTEL, OMAHA, NEB.

The top corners are rounded, and the bottom part of each side is flared so as to hold a filler or spacer tile that serves as the bottom of the form for the rib and also gives an unbroken surface for the plastering. The tiles serve as forms for the ribs and floor slab. Only light falsework is required to support the tiles during the construction of the floor. The top of the falsework consists of 2x8-in. planks, 24 in. c. to c., each supporting the edges of two rows of tiles and the spacer tiles.

This construction has been used in the Dawes Y. M. C. A. Hotel, at Chicago, and the Castle Hotel, at Omaha, Neb. The tiles are manufactured by the United States Gypsum Co., of Chicago.

Mixing Concrete Dry at a Central Plant

First-Prize Concrete Dry-Mixing Article in the "Engineering News" Prize Contest

By H. F. LaBrecque*

The problem of dry mixing and the economic effects of varying percentages of water added to the concrete at a central concrete-mixing plant were recently dealt with by the writer in putting into operation a plant designed and constructed by him on the contract for section 1, Route 29, of the New York Rapid Transit R.R.

A general view of the plant is shown in the accompanying illustration. It consists of: (1) A crushing unit, with 30x13-in. jaw-type crusher, sizing screens and bin, and a 16-in. belt conveyor running on an incline from the sizing bin, for storage piling. (2) A transporting unit, consisting of a 20-in. belt conveyor running in a 6x6-ft. tunnel from the sizing bin, underneath the stone and sand storage piles, to the foot of an 18-in. bucket conveyor, which receives the material and conveys it to the bins over the mixer. (3) The mixing unit, in which are placed a 1-cu.yd. mixer, measuring hopper, cement elevator, sand screen, of the revolving type, which also separates the gravel of specification size and deposits it in the stone bin; bins for 100 cu.yd. of stone and 50 cu.yd. of sand; and a 2000 bbl. capacity cement shed.

LAYOUT OF CONCRETING PLANT FOR SUBWAY CONSTRUCTION IN BROOKLYN

The plant is electrically operated throughout and will furnish 150 cu.yd. of concrete in 8 hr. Sand and stone are stored directly over the tunnel and fed to the 20-in. belt conveyor through a longitudinal opening in the tunnel roof. This opening is covered by short removable boards, which are taken up only at the point where feeding is in progress. It is generally found convenient to feed the stone to the transporting unit directly from the sizing bin and thus save the cost of rehandling.

The operating gang, exclusive of crusher force, consists of one man operating mixer, one man feeding cement to mixer; one man feeding cement to elevator, one man changing chutes and leveling bins, and one man feeding sand and stone to tunnel belt.

It has been found economical on this work to use steel back-dump carts in transporting the concrete to place. These carts are drawn by two horses and carry two six-bag batches conveniently.

The concrete is dumped onto the street decking a few feet away from a 42x13-in. steel hopper set flush with the top of the decking. It is then easily shoveled into the hopper, enough water being added to bring it to a working consistency, and deposited directly into the forms through steel pipe chutes.

Experiments were made in order to determine the most economical percentage of water to be added at the mixer and also to ascertain the advisability of using a dry mix. In making comparisons the items considered were: (1) Labor charge; (2) effect on transportation; (3) effect on mixer. The concrete is a 1 : 2 : 4 mix and is subject to Government inspection.

With the dry mixture the aggregates were proportioned and thoroughly mixed without water. On being dumped at the hopper a long-nozzle hose, discharging toward the hopper, was pushed through the pile and two laborers with hoes pulled the dry mixture through the water into the hopper. The load was deposited in about four minutes. It was found that a marked separation of the fine and coarse aggregates took place, due to dumping from mixer to cart, from jolting during transportation and from dumping load at hopper. It was also found that the mixing as effected by the laborers with hoes was insufficient to insure a well-mixed concrete. For these reasons it was required that six laborers, three on each side of the pile, take the place of the two, and that the mixture be turned over three times. This required from 12 to 15 min. to deposit a load.

Wet mixtures were experimented with also. Water was measured in a Ransome automatic measuring tank, which can be set to discharge the quantity of water desired. Varying amounts of water, equal to from 3 to 8% of the total volume of loose aggregate, were added to the concrete at the mixer. The higher percentages produced what would be called a good working concrete at the forms. During transportation, however, excessive free water and grout settled at the surface of the load. This either

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*With Newman & Carey Subway Construction Co., Inc., 1228 Nostrand Ave., Brooklyn, N. Y.

slopped over the back of the cart or was lost when the load was dumped. Compact settlement also took place in the cart. The concrete would not dump and was picked out of the cart with marked difficulty. More water had to be added at the hopper to obtain a working consistency. It took four laborers from 7 to 10 min. to deposit a load.

The drier mixtures were easily dumped at the hopper and produced little free water during transportation, but they adhered to, and built up so rapidly in, the mixer that their use had to be abandoned.

By varying the percentage of water between these limits it was found that a batch to which about 5% of water had been added gave a maximum working efficiency and minimized the disadvantages mentioned. Three laborers deposit the load in from 3 to 5 min.

In each case a foreman and three laborers were required to spade and deposit the concrete in the forms and, in addition to the force already mentioned at the hopper, completed the concrete gang.

The average haul is 0.75 mi. No disadvantages resulted in wetting the mixture and, as the economy is apparent, this method is being adopted.

There is always danger that some accident may occur to detain a loaded cart en route. This would be especially dangerous where the haul is long and where the load might be condemned on the ground that the set would be broken. Under such conditions dry mixing would be advantageous. A modification of the central mixing plant, eliminating the mixer and only proportioning the batch, would seem preferable, since dry mixing can be given little, if any, value there.

Resurfacing an Old Macadam Road with Monolithic Brick Pavement

By Harlan H. Edwards*

A thin-base (1- to 2-in.) monolithic brick pavement placed upon the prepared surface of an old macadam road makes a good permanent road surface. In this construction the first and most important step consists in the proper preparation of the subgrade for the slab.

The worn macadam surface should be loosened to the desired width and depth with a scarifier and a harrow applied to break up the lumps and smooth off the surface. A road grader can then be made use of to remove the excess stone and leave the subgrade nearly at the required crown. This stone should be moved to one side for use in the shoulders after the pavement has been completed. Suitable ditches, culverts, catchbasins and crossdrains should be provided where necessary. The subgrade should be rolled to a uniform, compact and even surface with a 10-ton roller, and will then be ready for placing the materials.

Upon the subgrade thus prepared the concrete materials should be distributed in the most economical way. A good ¾-in. graded gravel or stone should be used. The brick should be stacked along the side of the road in such order that they may be laid in the pavement with the minimum confusion and delay, while the sacks of cement may be placed on racks to keep them off the ground.

*Urbana, Ill.

Fine builders' sand, graded to pass a No. 16 screen, should be used for the joint grout. This should be put in sacks at the cars and placed along the road with an equal number of sacks of cement, so as to provide a uniform mix, with no loss of material or time in measuring.

Steel forms 5 in. high should be used. These are set true to line and grade, 500 to 1000 ft. in advance of the mixer. With a mixer of 8 cu.ft. capacity, which is sufficient for this work, two men can easily lay and strike off the concrete base for 1000 ft. of 9-ft. pavement in from 8 to 10 hr.—enough to keep ahead of the bricklayer at his fastest rate.

The concrete, mixed to a quaky consistency, is spread out between the forms and struck off to an even surface with a saw-board templet. The bricklaying should be carried on about 25 ft. from the mixer, thus giving the concrete time to lose the excess water and become sufficiently stiff. The brick will then be properly embedded when rolled to a smooth, even surface with an 800-lb. water-ballast hand-roller. Inspection should be made at this time, and all rough, broken or cracked bricks either turned over or taken out of the pavement.

The brick should be grouted immediately after the rolling is completed, taking care that the grout is of such consistency that all the joints are completely filled. The excess grout is cleaned off flush with the top of the brick. All operations should be within 100 ft. of the mixer.

After the grout has set sufficiently hard, a 2-in. layer of earth should be put on and kept moist for 10 days, and traffic should be kept off for at least three weeks. The earth should then be removed and the shoulders shaped and made ready for traffic.

The organization for this work usually requires 26 men. Ahead of the mixer are two men setting forms, three wheelers for the sand and gravel, one cement man, one fireman and mixer operator. On the other side of the mixer are two men spreading and striking off the concrete, one bricksetter, two batters, six carriers, two stackers (if brick are carried in by tongs), one inspector, one roller, three men to the grout machine, and one for pulling forms, covering and wetting down the pavement. In charge of these men, of course, there must be a competent foreman. A water-boy is generally required. With such an organization under ordinary conditions from 700 to 1000 lin.ft. of 9- or 10-ft. pavement can be laid satisfactorily in one 10-hr. day.

No expansion joints are needed in this pavement; but if desired, thin strips of tarred paper may be placed through the slab at intervals of about 35 ft. These would act as contraction joints, eliminating the danger of contraction cracks forming in a jagged line across the pavement, with the accompanying possibility of having several bricks loosened by traffic.

A Nonsuit in Stagnant-Water Litigation—An attempt to collect damages for the death of a 9-year-old boy from pneumonia alleged to have been due to a pool of stagnant water in the street in front of the residence of the boy recently failed in the lower court, and the decision was upheld in the higher court (Bruggeman vs. City of York, Penn., July 1, 1916; 98 Atlantic Reporter, 970). Two physicians testified that in their opinion the death of the boy was the result of the unsanitary surroundings, though admitting that both his anæmic condition and his infection with pneumonia might have been due to other causes. An abstract of the decision with reference to a typhoid-fever case suit (Gosser vs. Ohio Valley Water Co., 244 Penn. 59, 90 Atl. 540, Ann. Cas. 1915C, 685) is given in United States Public Health Reports, Jan. 5, 1917, p. 23.

Deflection and Wall-Girder Tests on Floor of a Flat-Slab Concrete Building

By C. E. Locke*

SYNOPSIS—Deflection measurements and cracks give important information on behavior of flat slab under load, together with data on column bending and wall-girder stresses.

A test of a reinforced-concrete flat-slab floor recently made on building J of the plant of the Pierce Arrow Motor Car Co., Buffalo, N. Y., showed interesting results. This building had just been completed by the contractor, Aberthaw Construction Co., of Boston, Mass. Two adjacent wall bays on the fourth floor were chosen for the test, since the smallest columns there would have the least effect in restraining the action of the floor slab, and it was believed to be the most severe test to load the wall bays only. A brief outline of the structural features of the building, as designed by the contractor, is as follows:

The floor slab is designed for 200 lb. live-load, 120 lb. dead-load; the slab is 9 in. thick plus 1 in. finish; the drop panel is 7 ft. square, 5 in. thick; the interior column head is 60 in. in diameter; the wall columns have a bracket, as shown on the drawings. Over the interior column heads are two 1-in. round rings 4 ft. 6 in. and 9 ft. in diameter. Eight 1-in. round radials are bent down into the columns. Half-rings with five radials each are placed over the wall columns. The bands of floor steel are designed according to the Chicago building code and placed as is customary with the four-way system of reinforcement. In the wall bays both the rectangular and diagonal bands have twenty-two ½-in. round rods. Nine ½-in. round rods are placed as half a rectangular band along the outside of the bay. The steel is 2 in. below the top of the slab over the columns and 1 in. above the bottom of the slab in the center. At right angles to the rectangular bands are placed fifteen ½-in. round rods in the top of the slab. Interior bays have eighteen ½-in. round rods in each band. The roof slab is 7 in. thick. The parapet wall beam is 9 in. wide, 38 in. deep.

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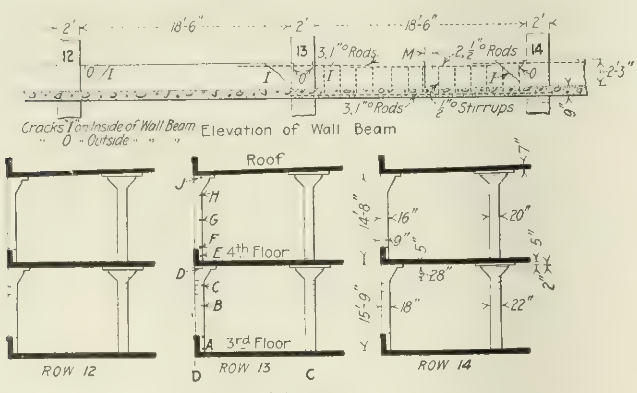

Deflections of Columns D13 in Inches						
Point	Moved	450 lb Load	600 lb Load	150 lb Load	No Load	No Load
A		0.0	0.00	0.00	0.00	
B	Out	0.07	0.13	0.06	0.05	
C	"	0.09	0.15	0.07	0.05	
D	"	0.04	0.06	0.04	0.02	
E	In		0.05			
F	"		0.10			
G	"		0.05			
H	"		0.00			
J			0.00			

FIG. 1. ELEVATION OF WALL BEAM AND OF COLUMNS UNDER LOADED SECTION

Showing cracks and, in table, column deformations

The wall-beam reinforcement is shown in Fig. 1 and the column schedule in Table 1.

TABLE 1. COLUMN SCHEDULE

Columns	Size	Mix	Vertical Steel	Hoops
Fourth story wall. . .	24x16-in.	1-1½-3	Four 1-in. round	⅜-in. round, 12 in. c. to c.
Fourth story interior.	20-in. round	1-2 -4	Four 1-in. round	⅜-in. round, 12 in. c. to c.
Third story wall.	24x18-in.	1-1½-3	Four 1-in. round	⅜-in. round, 12 in. c. to c.
Third story interior.	22-in. round	1-1½-3	Four 1⅛-in. round	⅜-in. round, 12 in. c. to c.

The columns, floor and wall beam were concreted July 1. Bags of gravel and cement were used for the load.

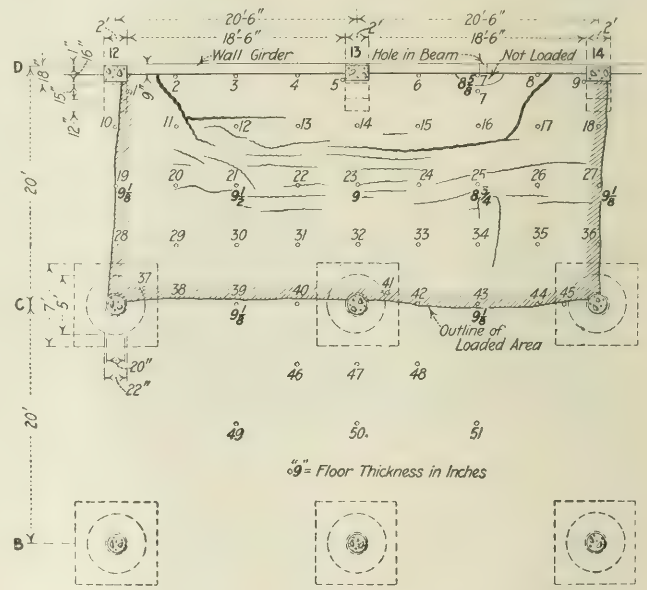

FIG. 2. PART OF FLAT-SLAB FLOOR UNDER TEST WITH CRACKS UNDER MAXIMUM LOAD

These were placed by layers, the first layer on Aug. 2 and the last on Aug. 12. The final load of 600 lb. per sq.ft. remained until Aug. 14, when the unloading commenced in order to use the material to finish other parts of the building. This tested the floor, then six weeks old, to about two and a quarter times the total design load, or three times the design live-load. Loading beyond 600 lb. was stopped, as it was not desirable to take the chance of permanently damaging the building by stressing the structure beyond its yield point.

Deflections of the Floor Slab

Floor-slab deflections at various points were measured by means of an engineers' Wye-level and rod readings on the ceiling below. Two levelmen reading the same rod at the same time obtained quite consistent results. The

TABLE 2. FLOOR DEFLECTIONS IN THOUSANDTHS OF A FOOT, NEGATIVE UNLESS MARKED +

Loaded Reading Loads, Lb. Points	8-7-16 8-8-16 350 Lb.	8-9-16 8-10-16 450 Lb.	8-10-16 8-11-16 500 Lb.	8-11-16 8-11-16 550 Lb.	8-12-16 8-14-16 600 Lb.	8-17-16 8-18-16 0 Lb.
1	0	0	..	.	4	0
2	2	4	..	..	8	3
3	2	3	..	.	7	1
4	2	5		.	9	4
5	1				4	+1
6	4	4			9	2
7	5	6	7		12	6
7′	11	17	21	21	28	14
8	5	6			12	6
9	3	1	2	4	5	2
10	4	7		.	15	4
11	10	16		.	29	9
12	13	19	..	..	37	15
13	14	22			33	15
14	10	15	18	20	27	11
15	14	20	.	..	37	14
16	17	27	..	..	43	22
17	12	18	..	..	29	16
18	5	6	..	.	14	5
19	7	11	..		20	7
20	14	20			37	12
21	19	29	36	36	50	21
22	21	30	39		52	22
23	18	29	33	37	49	19
24	21	32	36		54	22
25	21	35	42	47	59	26
26	23	34	29		42	20
27	11	13	..	..	23	13
28	6	6	..	..	12	5
29	9	13	..	..	23	8
30	14	19	..	..	31	12
31	14	19		.	36	17
32	12	17	24	24	31	12
33	16	21		.	36	16
34	18	26	..	.	44	20
35	16	19	..	..	32	15
36	7	6	.		14	7
37	4	4	5	6	5	+2
38	5	4	..	..	9	2
39	7	7	..	..	16	6
40	7	5	..	..	11	6
41	2	.	..	..	12	1
42	6	5	..	..	13	9
43	12	13	..	..	24	13
44	6	7	.		13	6
45	3	2	5	5	9	4
46	1	+2	..	..	2	3
47	2	+2	.		+1	3
48	.	0	..	..	2	6
49	2	+1	.	..	+2	3
50	0	+3	.	.	+2	1
51	1	+1			+1	4

averages of accepted consistent readings are tabulated in Table 2. Many of the apparently inconsistent deflections may be accounted for by the varied thickness of the rough floor, shown at various points in Fig. 2. The position of the load as indicated by the outline of the loaded area probably had some effect. Readings taken the day after all load was removed showed an average recovery of about 60%. Further readings, a week later, indicated no further recovery. Even while yet subjected to a severe overload, the floor showed considerable recovery when a part of the load was removed, which shows that the floor was not stressed beyond its yield point. Fig. 4 shows a curve of the average deflection of the five lowest points with the varying load. The curves for different loads showing the shape of the slab at the middle of the two bays indicate that points 21 and 25 would have deflected more had the adjoining bays been loaded, whereas point 23 would probably not have been affected.

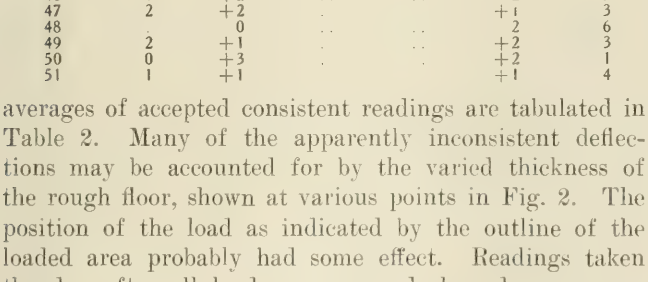

FIG. 3. WALL BEAM CUT TO FACILITATE MEASUREMENTS

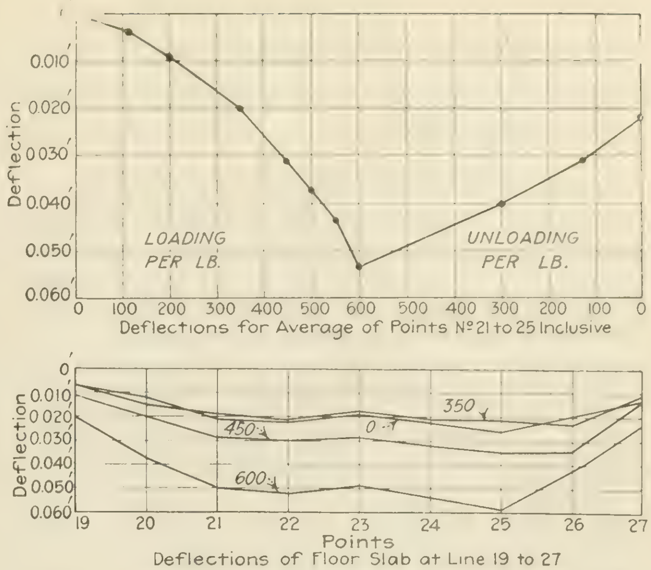

FIG. 4. DEFORMATION CURVES IN MIDDLE OF SLAB

Cracks in the floor slab, shown in Fig. 2, were noticed at about 450-lb. load. Most of these cracks were visible only upon close inspection. The two largest cracks, as indicated by heavier lines, were quite visible 10 ft. away. Had the adjacent wall bays been loaded, points 10 and 18 would have deflected more; then this large crack would probably have continued longitudinally instead of turning off toward the wall beam. As the load was removed, the cracks were less noticeable, but the larger ones can still be seen quite plainly. The load was first removed around columns *D*-13 and *C*-13, the floor swept clean and the top of the slab inspected to see if any cracks developed there. None were found, although fine hair cracks could not have been detected in the very rough surface of the slab.

Bending in the Columns

The effect of the test load upon the columns was quite serious. The cracks which developed are shown in Fig. 1. Even the columns at corners of the loaded area were affected, thus showing the serious condition of eccentric loading. The interior column cracks closed up entirely as the load was removed, but wall-column cracks, especially in the center column, are still apparent. When the floor was loaded about 100 lb. per sq.ft., points *A* to *D* were marked in a vertical line on column *D*-13, by means of a transit. Later at different loads the deflections were measured from a vertical line assuming that point *A* had not moved. The very large deflection of 0.15 in. was observed at point *C* at the center of the group of cracks. The compressive stress in the concrete at *C* certainly must have been exceedingly high, as the cracks extended halfway across the column. A crack developed at *F* which was the widest of them all, and this one apparently nearly cut the column in two parts. The effective thickness is only 14 in. at this point, as a slot is left for the window sill to be concreted later. At full load, points *E* to *J* were marked in a vertical line and the recovery noted at no load. This amounted to 0.10 in., assuming that point *J* is stationary.

From the size and extent of the cracks and comparative deflections, it is quite evident that the wall columns are the weakest parts of this design. A better-balanced

design would either provide for the excessive stresses caused by bending moment in these wall columns or provide sufficient strength in the floor itself to carry the load with but little assistance from negative resisting moment over the wall columns.

Investigation of Wall Beams

In view of the fact that half a typical rectangular band was placed along next to the wall beam, the writer believed that the wall-beam steel was unnecessarily heavy; therefore, in one of the wall beams a slot 8 in. wide was left down to the floor slab, which would nullify to a large extent the value of the three 1-in. round rods in the bottom of the beam, thus leaving the load to be carried only by the band in the floor slab and the two half-beams each acting as a cantilever out from the column. This slot and reinforcing steel are shown in Fig. 1. The ½-in. rods in the top of the beam were cut and the ends of one of them filed to a point, as shown in the accompanying view (Fig. 3). The extra rods are for temperature and shrinkage stresses. One of them was bent before the load was applied. Readings of the distance M between the points of the rod were made with an inside micrometer, and are shown in Table 3. The total variation of this distance was only 0.028 in., so that the changes of temperature caused more variation than a small increase in load.

TABLE 3. DISTANCES M BETWEEN STEEL POINTS AT SLOT IN BEAM

M	Load Lb.	Temp., Deg. F.	M	Load, Lb.	Temp., Deg. F.
4.221	0		4 203	470	84
4.223	56	76	4.202	497	80
4.217	56	88	4 198	551	90
4.223	56	83	4 206	551	70
4 214	100	95	4 205	604	79
4.220	100	86	4 201	604	62
4 224	172	73	4 198	570	66
4.220	172	82	4 197	570	80
4.209	354	94	4.196	430	85
4 211	354	83	4 200	354	82
4.209	354	87	4.208	..	87
4 216	354	79	4.212	...	82
4.208	444	87	4.224	...	65
4 209	444	85			

These readings only show how small the deflection really was; and they might have been useful to indicate any sudden drop of the beam, had there been any such fact to observe. The maximum deflection at point 7, just below the slot in the beam, was only 0.012 ft., which was not sufficient to affect the 12-ft. high steel sash then in place and glazed below. Considering these small deflections and the lack of any cracks to indicate any failure due to this slot in the beam, the writer believes the reinforcing steel in this beam could have been very materially reduced without sacrificing any desirable strength. The stirrups and the hooked ends of the floor rods tied the beam and floor together. The cracks observed in the wall beam did not run clear through, but were different on the outside than on the inside of the beam, as shown in Fig. 1. Apparently, the top of the beam moved in toward the load, as the floor deflected more at points a few feet away from the beam than at the beam itself. The columns, being more rigid, probably deflected less than the beam, thus producing torsion at each end of each beam, causing the cracks, as shown. As these were only fine hair cracks, the results do not indicate any weakness in this particular design, but only add one more complication to consider in the design of flat-slab floors.

Safer Water for Bay City Urged in Report and Campaign

The need for uptodate water-works and the present dangers from typhoid due to a supply polluted at times are set forth convincingly in a report on the water works of Bay City, Mich., made recently by Burns & McDonnell, consulting engineers, Kansas City, Mo. Many illuminating diagrams showing typhoid dangers at Bay City and how these have been reduced by water purification elsewhere are included in the report. These diagrams are being used in lantern-slide form in a campaign for an $850,000 bond issue for carrying out improvements to the works recommended. The whole report, it may be added, is well designed to convince the average citizen, as well as the city officials, that the whole water-works system is in bad need of overhauling and that there is particular need for a purer supply.

A 30-in. wood-stave pipe line, 4 mi. long, in use about 45 years, is an interesting element in the original Bay City water-works, put in use in 1872. This pipe line extends from the original, or East Side, pumping station, to a dredged channel, protected by breakwaters, extending nearly a half-mile into Saginaw Bay, to a point about 2½ mi. east of the mouth of the Saginaw River. The city is built on both sides of the river and discharges its sewage into that stream. With increasing frequency the city has drawn a part of its supply directly from a badly polluted portion of the river, as stated in the following extract from the Burns & McDonnell report:

> The capacity of the 30-in. wood-stave pipe, which serves as the supply line for the East Side station, was tested when first installed over 40 years ago and was reported to be more than 8,000,000 gal. per day with the water in the wells lowered 5 ft. In 1879 an 18-in. emergency intake to the river was installed; in 1884 the full capacity of the main conduit was reported to be 5,000,000 gal.; in 1896 the emergency river intake was enlarged to 30 in. The present capacity of the bay conduit apparently is not more than 4,000,000 gal. per day, indicating that there has been a steady decrease in the capacity of this pipe line. This line is over 40 years old and is undoubtedly in poor physical condition and partially filled with sand and mud. Consequently, the river intake, which was originally intended to be used only in case of great emergency, has been resorted to more and more frequently, and during the last three years it has been at least partially open on more than half the days of the year. All the water which the bay conduit will carry is utilized, and the deficiency is made up by opening the valve on the river intake enough to supply the demand.

The river intake draws from a bayou into which city sewers discharge—one 100 ft. and two 1500 ft. from the emergency intake. The river receives not only sewage from Bay City, but also from Saginaw, Flint, Owosso and other places above.

The East Side (East Bay City until consolidation with Bay City in 1905) is supplied from an independent water-works plant, the pumping station for which is located on the shore of Saginaw Bay about 2¾ mi. west of the river mouth and 4 mi. north of the city. A 40-in. riveted steel intake pipe, 2200 ft. long, extends from the suction well to a submerged timber crib, in water 10 or 11 ft. deep. This intake has always met the demands upon it, except that for a few times, only, anchor ice has caused trouble, but never a complete shutdown.

The water delivered by each of the two pumping stations is treated by liquid chlorine, but during the three months preceding the report there were many cases of typhoid fever in Bay City. From Aug. 7, 1916, "when daily tests were begun by the city bacteriologist, the

average number of bacteria in the raw river water was 5200 per c.c. and in the treated water 3200; in the raw bay water 3680 and in the treated water 560." The water supplied the West Side showed an average of 3260 raw, and 210 chlorinated. Besides its unsatisfactory bacterial quality the water is subject to considerable turbidity.

The average typhoid rate of Bay City for the 11 years ending with 1916 (one month short) was 38 per 100,000, while the rate for 1916 alone (one month short) was 32.

Estimates of the cost of putting the Bay City waterworks in good shape total $881,500, but of this it is advised that $64,000 for a new intake crib and pipe be postponed and $20,000 for meters be provided from revenue. The remaining sum of $837,375 includes as its chief items the following: Four 5,000,000-gal. steam-turbine-driven centrifugal pumps, with foundations, all complete, $33,000; 2,000,000-gal. reinforced-concrete settling basin (3⅕ hr. detention), $80,000; mechanical filter plant, including 10 concrete units with effective area of 540 sq.ft. each, 800,000-gal. clear-water well, brick filter house and all piping, etc., $200,000; one 10,000,000-gal. cross-compound high-duty crank-and-flywheel pumping engine, $37,500; boilers, $29,000; 36-in. cast-iron force main, $290,000; 24-in. flexible-joint cast-iron pipe under river, $72,000; replacing wood distribution mains with cast iron, $72,000; new feeders in distribution system, $35,000.

Apparatus for Mixing Soap and Alum Waterproofing with Concrete

By Homer V. Knouse*

In relining the slopes of basins 1 and 2 of the Walnut Hill reservoir at Omaha, Neb., as described in *Engineering News* of Oct. 5, 1916, waterproofing consisting of bar soap and sulphate of alumina was added to the tempering water before it entered the gaging tank on the top frame of the mixer. To obtain an accurate control of the quantity of these materials applied per cubic yard of concrete, special devices were fitted on the No. 11 Smith mixer performing the work.

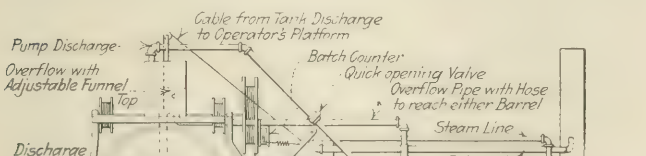

FIG. 1. CONCRETE-MIXING PLANT WITH ATTACHMENT FOR ADDING WATERPROOFING TO MIX

*Construction Engineer, Metropolitan Water District of the City of Omaha, Omaha, Neb.

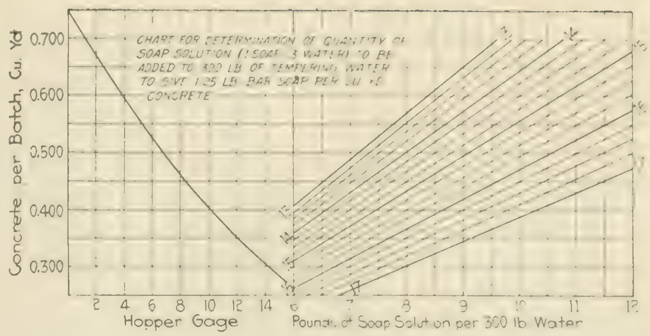

FIG. 2. CHART FOR DETERMINATION OF QUANTITY OF SOAP WATERPROOFING SOLUTION

Common bar soap was placed in a 25% solution in barrels on the ground level, the action being hastened by the use of steam coils. A 25% solution of sulphate of alumina, such as serves as a coagulant in water-works practice, was obtained in a third barrel, all so located that the fireman at the boiler could do the necessary work of charging and stirring. Two calibrated barrels on the mixer level were used for preparing the tempering water and were connected to the suction side of a 1-in. centrifugal pump so that each could be used while the other was being prepared. This pump discharged into the gaging tank on the top of the mixer frame, and from it the water was discharged into the drum through a lift valve in the bottom. In order to control the amount of water per batch, an overflow, discharging into the mixing barrels, was applied in the form of a funnel screwed to a long threaded nipple. This gave a large area of weir for quick discharge and allowed adjustment as the moisture content of the aggregates varied.

After mixing, the concrete was discharged into a calibrated hopper; and at frequent intervals the quantity of concrete per batch was measured, although it was found that by the methods followed in charging the skip very little variation occurred. The amount of tempering water per batch was determined by a gage on the upper tank, and from these data the proper amount of soap solution per measured quantity of tempering water was obtained quickly by use of the chart shown in Fig. 2.

Three men were required to operate this equipment—an operator, a fireman and a man to prepare the tempering water. All operating levers and valves were within easy reach of the operator, and the sequence of operations was so arranged that a maximum length of time of the materials in the drum was obtained in each cycle.

New Electric-Lamp Equipment for range lights and lighthouses has been devised by the United States Bureau of Lighthouses. The new range light has two units, each containing a 6-volt, 30-cp. concentrated-filament incandescent lamp in a silvered parabolic reflector throwing its beam through a red glass. The lamps may be run on storage-battery or city-system current, either one being automatically substituted for the other in case of failure. Also in case one lamp fails the other automatically is connected into circuit. A device for automatically replacing incandescent electric lamps burned out in service has been developed and is now in use at several lighthouse stations. The device consists of three lamp sockets mounted radially at 120° on a spring-actuated shaft, which is supported on a frame of proper height to bring the upper lamp in the focus of the lens. The shaft is held against rotation by means of a latch and ratchet wheel. Should the lamp in service burn out, the latch is released by means of electromagnets, and the shaft revolves 120°, bringing the second lamp into service. The third lamp is similarly brought into service when the second lamp burns out.

Helpful Suggestions for Surveying Country Highways

By Samuel P. Baird*

SYNOPSIS—Some pointers on special survey methods and devices from the practice of an experienced surveyor.

The fieldwork preliminary to country-road improvement is often done by young men just out of college, and a few pointers on labor-saving methods by an old-timer may not come amiss. Without further preliminaries I will make a few suggestions based on my own experience.

Run Levels First

I always run a line of levels the first thing, locating benchmarks about every 1000 ft. and near all structures. Each benchmark should be given a number, for it is quite an economy of time to record them by number rather than describing them every time they are used.

By running the levels for the benchmarks first the engineer will acquire a certain amount of information about the road, the volume and kind of travel, the names of property owners, etc., which will be an aid in running the center line.

Where an experienced rodman is available, I use a target rod for B. M. work. Both leveler and rodman keep notes to check each other. Levels are run back again unless a check can be made on a United States Government B. M. When levels are run back, check readings are taken on the benches located going out.

For all leveling except the most exact B. M. work I use a self-reading rod graduated to feet and tenths. The rods are generally 16 ft. long, graduated on both sides, the zero of the two sides being at opposite ends of the rod. This is a time saver, as rodmen will sometimes get the rod wrong end up; but with this method of graduation it is only necessary to turn the rod around instead of end for end. The rods were home made.

I have used for some time an addition to the ordinary marking of leveling rods. I have foot numbers painted on the rod just at the left of and just below the 0.2, the 0.4, the 0.6 and the 0.8 marks. This is for the convenience of the leveler on short sights, avoiding the occasional necessity of calling "raise the rod." This added feature is very inexpensive and is a time saver. The figures can be small, as they will be used only on very close sights.

Locating the Center Line

We generally try to find a center line that will most nearly bisect the portion of the highway between fences, or sometimes a center line that will most nearly bisect the old roadway as indicated by the berms and cuts. It is not essential that the center line of the survey be made the center line of the road. But if it is made so, it will simplify the work considerably. To get a center line located on either of these plans requires considerable work, unless you use a short-cut similar to the method outlined herewith.

Have a number of frames or signals prepared (see Fig. 1)—something that can be stood up on a hard road or on a frozen hillside without the labor of digging a hole. The frames that I have had the most success with are made of $\frac{7}{8}$x$\frac{7}{8}$-in. poplar or cypress, dressed on four sides. Two 3-in. strap hinges and two small screw clamps are required for each signal. The central, or upright, pole should be about 8 ft. long; two diagonal braces should be about $4\frac{1}{2}$ ft. long and the two horizontal braces about $3\frac{1}{2}$ ft. long. When closed these frames nest very well for storage or forwarding purposes.

With a number of the frames ready (say about ten, depending on the length of the tangents) the work is started by locating a frame or signal at the center of the road at some governing place. Continue locating these frames at governing points on the two adjacent tangents.

With a plumb bob and line one can soon locate the intersection of the two lines of signals (or of the tangents). This point of intersection should be permanently marked and referenced. If in the traveled portion of the highway, a 60d. spike driven through a tin-roofing cap and a 4-in. square piece of canvas will generally hold the place for several months. A spoonful of road oil will be an aid in quickly locating nails at station points.

The transit line should proceed along the tangents (the points of intersection having already been located) until a little short of the probable P. C. Then the instru-

FIG. 1. DEVICES USED IN HIGHWAY SURVEYING
Above—Frame for locating center line of roadway. Below—Stake pocket and 7-ft. plumb line from special tape

*Engineer and Contractor, Columbus, Ohio.

ment should be moved up and the intersection angle and the external distance measured.

One of the chainmen, if possible, should be fully instructed in figuring the curves, so that he can check the instrumentman, thus saving valuable time by avoiding mistakes.

I use a rubber stamp or a printed-sticker form (Fig. 2) for inserting in the notebook the properly arranged curve data. This practice preserves all the curve data in a uniform record for later use.

For the length of curve I use the actual length measured along the arc, for I had the necessity of this called very forcibly to my attention in checking some concrete roadwork that had quite a number of short-radius curves. I found that there was about 50 ft. more road than the stationing indicated, and this at $2 per ft. cost the contractor $100.

In this connection I will say that the measurement on the center line should be made on the same slope as the finished road to cover the actual distance that the contractor will be required to construct the pavement. It is well to remember that the engineer is the engineer for the contractor as well as for the state, county or whoever it may be. As soon as the tangent distance is ascertained, the P. C. and P. T. stakes can be put in, preferably in the following order: First, the P. C. stake; then measure from the last station to the P. C., so that the deflection angles can be figured to make the curve points come at even stations and plus fifties. Then the P. T. can be put in while the calculation is completed. This avoids using any equation stations.

BEARING N 35° 30' W.
ANGLE TO LEFT 44° 20'
RADIUS 10° = 573.7'
TANGENT 233.7
DEF. FOR 100 FT 5° 0'
DEF. FOR 50 FT 2° 30'
DEF. FOR 1 FT 0°. 3'
DEF. FOR 8.5 FT 0° 25.5'
DEF. FOR 34.8 FT 1° 44.4'
P. C. 17 + 41.5
L. C. 4 43.3
P. T. 21 + 84.8
SUB. CHORDS 8.5 1-34.8 4-50.05
BEARING N 8° 50' E

FIG. 2. STICKER FOR NOTEBOOK

Marking Survey Points

The P. C., P. T. and P. I. points should be well referenced by at least three references each. Reference stakes should be outside of the limits of the work, located preferably close to buildings, fences or trees as insurance against disturbance.

Where the intersection angle is large, it is advisable to locate a point on each tangent produced, which can be occupied as instrument points or for placing a permanent flag. Lines run without a constant foresight or backsight are not generally straight. A permanent flag will save time. In the winter when snow is on the ground I use red flags, and during other times of the year white flags, on all signals.

Some highway departments require that a spike or nail be driven at each station point; as these invariably come in the traveled portion of the road, it will be quite an aid to the work to have the chainmen equipped with a pair of 8-in. pliers to hold the spike at its midlength. This prevents to a large extent the bending of the spikes while driving.

It has been my custom to set the witness stakes not exactly opposite the spike, but an even 100 ft. from the last station spike and the distance off the line from the succeeding station that is marked on the back of the stake. This makes each witness stake act as a reference to the two station points. For instance, the witness stake at Sta. 105 is set at 100 ft. from Sta. 104 and 20 ft. from Sta. 105. On curves 50-ft. points are marked and referenced. The station numbers are painted on fences, etc.

Special Steel Tape

For all measurements along the center line I use a 100-ft. steel tape, graduated to feet, except at the ends, where the feet are graduated to tenths. Besides the usual markings I have all my tapes equipped with a clip soldered on at the 0-, 25-, 50-, 75- and 100-ft. points (see Fig. 3).

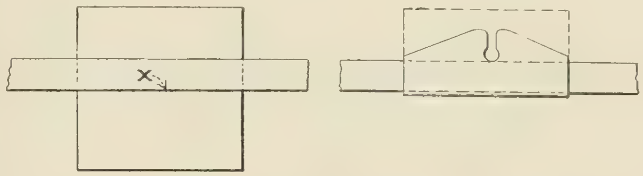

FIG. 3. CLIPS FOR HOLDING PLUMB LINE ON STEEL TAPE

The first operation is to solder on one side of the tape a piece of heavy tin as shown, care being taken not to have any solder along the edge X as it will prevent a good fold. The second operation is to fold on the line X and solder the laps together. Then trim the double, soldered laps as shown

The clips are about 1 in. long and project from the side of the tape about ¼ in. They have a slot filed in them sufficiently wide to carry a plumb line and as deep as possible without cutting into the edge of the tape. These slots are filed exactly opposite foot marks.

The advantages are twofold: The accuracy of the work is increased when using a plumb bob, as the plumb line is placed in the slot in the clip and held there with ease and certainty even when using 7 ft. of string; the clips are also very convenient in quickly locating the quarter-points on the tape.

Cross-Sectioning

For taking cross-sections the 100-ft. steel tape is placed on the ground from one station point to the next, using it as a straight-edge. The pluses are read on this tape, and the offset from it to fences, trees, poles, etc., is read with a metallic tape.

The tape used for cross-sectioning is one improvised of two metallic tapes sewed together so as to give graduations on both sides. This is a time saver. I am arranging now to have tapes graduated the same on both sides.

Cross-sections should be taken much more frequently than is customary and should be run out at least 30 ft. from the center line. The grading cost of most highway work runs about 15% of the total; and as it is usually estimated at about one-half what it actually costs, great care should be taken to see that no yardage is missed in taking the cross-sections.

It has been my plan to set side stakes opposite the points on the center line and when taking the levels along the center line for profile purposes to take levels on the ground at each of these side stakes, and to give the center-line grade on them. If these stakes are preserved (and there is no reason why they should be lost if they can be placed in the fence line), it will be possible

for the contractor or the inspector to give line and grade from them at any time.

It is my practice to give all cuts and fills from the surface of the ground at the base of the stake, except for concrete road and street work. In using this plan, even if the stake is knocked out and is not lost, the work can proceed, as the ground elevation is very likely not disturbed, while if the elevation had been given on the top of the stake it would have been lost if the stake were disturbed.

For carrying stakes I have tried straps, baskets, boxes, and have finally adopted a canvas three-compartment stake pocket. This occupies very little room when empty, it is easy to handle, keeps the stakes in order and is very much superior to anything else that I have tried or seen. It is shown in Fig. 1. It will hold fifty 1⅜x⅞x18-in. stakes, which should all be numbered in advance, except perhaps half a dozen for use at unexpected points. The stake compartments are 2 in. wide by 16 in. high by 12 in. deep. The stakes fit snugly in the pockets, to prevent the disturbance of the serial order in which they are arranged.

Making Large Concrete Blocks for the Panama Canal Breakwaters

Limon Bay, at the Atlantic or northern entrance to the Panama Canal, is protected against the occasional norther by two breakwaters, one extending northeasterly from the west point of the bay (Point Toro), the other a detached breakwater of recent construction extending from the east point in a straight line to about 2000 ft. east of the outer extremity of the west, or Toro, breakwater. While both of these breakwaters have for their main structure heavy rock dumped from trestles, which incidentally have had to be replaced during the past year after being wrecked by northers, both have as additional protection of the slope large concrete blocks that are dumped overboard along the rock face of the breakwater. These blocks are cubes varying in linear dimension from 1 ft. 6 in. to 7 ft., the largest weighing about 25 tons. Somewhat different methods of manufacture were used in the blocks for the west and for the east breakwaters, so each one will be described separately here. About 20,000 cubes constituted the total number used. Some were built by contract and some by Government forces.

The east-breakwater blocks were built by Government forces both at Cristobal and near Coco Solo. The former plant is illustrated in Fig. 1. As will be noticed there, the plant comprises a concrete mixer mounted on flat-cars controlled by a locomotive crane, which at the same time feeds the mixer from material cars run in on an adjacent track. The concrete is delivered through chutes to the forms, which are distributed in the yard, as shown.

The detail of the forms is shown in Fig. 2. They are made up of metal-lined plank in the form of a cube with one side and the top open. In setting the form to receive the concrete, it is placed with its open side closed by a block previously poured, the side of this block being faced lightly with a coating of tar and a sprinkling of sand. As soon as the concrete has been poured into the form and the latter is ready to be removed, it is drawn back until its open end is flush with the block just cast. This block is then faced as the previous one, and the pouring of the next block proceeds as before. In order to save space, the blocks are cast in tiers of two and three. In the view in Fig. 1, for instance, the blocks in the rear are in some cases as high as the third tier.

These blocks are moved from the stacks in which they are formed to flat-cars and hauled on the Panama R.R. to the breakwater. The loading onto the cars is accomplished with a crane provided with the same sort of hook as is shown in Fig. 5, gripping openings cast for that purpose in the sides of the blocks.

FIG. 1. CASTING YARD AT CRISTOBAL FOR CONCRETE CUBES USED IN EAST BREAKWATER, LIMON BAY

For the west breakwater the blocks were cast in a special plant by contract, the Panama Canal furnishing gravel and cement delivered to the point of manufacture. The contractors had a plant at Gamboa. This comprised a wooden trestle from which the aggregate was dumped, and an adjoining traveling mixer plant mounted on flat-cars running on tracks parallel to the gravel track. Concrete was delivered to the forms by spouts, as in the other plant. The forms, however, being somewhat larger than for the other breakwater, were made stronger. Fig. 4 shows the details of one such form. The

FIG. 2. FORMS FOR 5-FT. CONCRETE CUBES USED ON PANAMA BREAKWATER

two corners diagonally opposite are nailed solid. The other two corners are furnished with wedge blocks and are free to move. The two pieces of form making the four sides are placed on 9-ft. square platforms with the chamfer strips for the bottom nailed to the platform, the outside edge giving the 7-ft. square. The forms are wedged up to the chamfer strips, and the sides and tops are then placed. To remove the forms, the wedges

FIG. 3. DERRICK BARGE PLACING BLOCKS ON WEST BREAKWATER, LIMON BAY

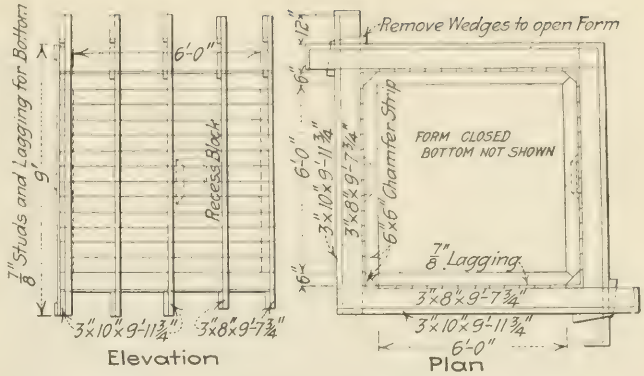

FIG. 4. FORMS FOR 7-FT. CUBE CONCRETE BLOCKS, PANAMA BREAKWATER

are taken out, the corners spread and the entire form lifted.

As in the other plant, these blocks were poured in tiers. In handling the blocks two 40-ton locomotive cranes with outriggers were used, balance being secured by additional loads on the coal and water tanks of about five tons of pig iron. The cranes had the tongs shown in Fig. 5. Each pair weighed about 2600 lb. and had a clear width when open of about 7 ft. 2 in. The channel iron that kept the jaws from closing to less than 6 ft. 7 in. was so arranged by notch and pin that when the

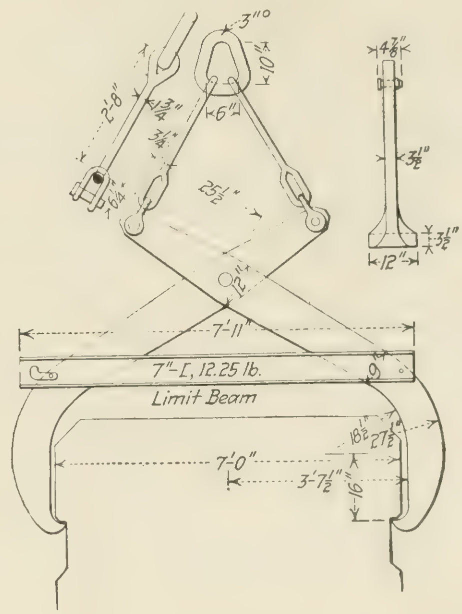

FIG. 5. HANDLING TONGS FOR LARGE CONCRETE CUBES

hook dropped over the top of the block and the jaws were open to clear the block, the channel held them open about 7 ft. 2 in., which enabled the hook to be lifted off.

These blocks were not only carried out to be placed by a floating crane, as shown in Fig. 3, but were also run out onto the breakwater trestle on cars and dragged off by the same general type of plow that is used in clearing the dirt-cars in the other parts of the Panama work.

The blocks were made from run-of-bank gravel, which, except in a few instances, ran quite uniform. Work was started with a mix of 1 : 6, but this was afterward changed to a richer mix of 1 : 4½, which proved quite satisfactory.

The average cost was about $3.90 per cu.yd., exclusive of the cement and gravel, which in the blocks made by contract was furnished by the Commission.

Drill-Sharpening Methods at the United Verde Mine, Arizona

Second-Prize Drill-Sharpening Article in the "Engineering News" Prize Contest

By Frank Richards*

The ground in the United Verde mine is hard, and as a result the steel is quite dull when it reaches the sharpening plant. This is especially true of the steel used in conjunction with the Leyner drills. The sharpeners are in continuous operation during the entire 8-hr. period. A highly efficient system of collecting, sorting and routing, sharpening and distributing has been developed at this mine.

DAILY MOVEMENT OF STEELS AT UNITED VERDE MINE

Average number of steels sharpened per day	1,800
Type of bits	Crossbits
Length of steels	2 to 10 ft.
Shanks	60% Leyner-Ingersoll drill shanks with lugs, 20% "Jackhamer" shanks with collar, 20% Stopehamer shanks without collar
Grade of steel	0.75 to 0.95% carbon
Sharpening-plant equipment	Two No. 5 Leyner sharpeners and one No. 3 Leyner sharpener, each equipped with Davies hole-blowing device; three Davies punching machines; three oil furnaces and one tempering furnace
Shop blacksmith force	Three operators sharpening, three helpers heating and punching, one blacksmith tempering, and one utility man
Working shift	One 8-hr. shift per day

Dull steels are collected on the various levels underground, brought to the surface and sorted by nippers onto steel cars. These cars consist of trucks on which are mounted four-section bodies, revolving on ball bearings (Fig. 1). By sorting at this point, the blacksmith is saved several miles of walking each day.

The sharpening plant is located aboveground and has three units, each consisting of an oil furnace, Davies air-operated punching machine, Leyner drill sharpener and Davies blow gun.

The steel travels from the dull-steel car in approximately a straight line through each unit to a car for the sharpened steel (Fig. 3). The sequence of operations is as follows: The helper unloads the dull-steel car and places the steel in the furnace; when it comes to the proper heat, he removes it with his right hand, places it in the punching machine, while at the same time his left hand operates a clamping lever, then moves a few inches to the lever that controls the punch—the entire operation is completed in 2 to 3 sec. The hole in the steel is opened for 3 to 4 in. The helper passes the steel to the blacksmith, who receives it in his left hand, places it in the sharpener, bringing the machine into operation with his right hand. After the bit is formed, the steel is reversed and the shank end is placed against the blower; this movement is really a step in transferring from the sharpener to the car. It is desirable to stand the steel with the bit up.

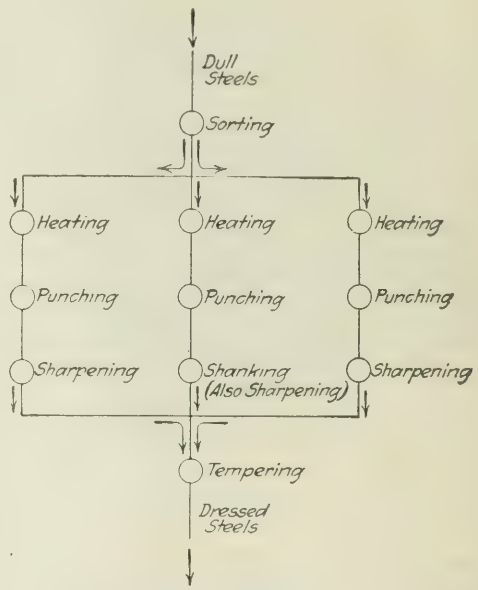

FIG. 3. SEQUENCE OF HANDLING AND SHARPENING OPERATIONS

This method is identical for each sharpening unit, the sharp-steel cars from all traveling to one tempering forge. The steels are then brought to a tempering heat and delivered to the slack tub. Plunge tempering is employed, the bits in water and the shanks in oil.

Between the sharpener and the temperer the steel cools to normal temperature and is ready for reheating. The utility man takes care of grinding and dressing the

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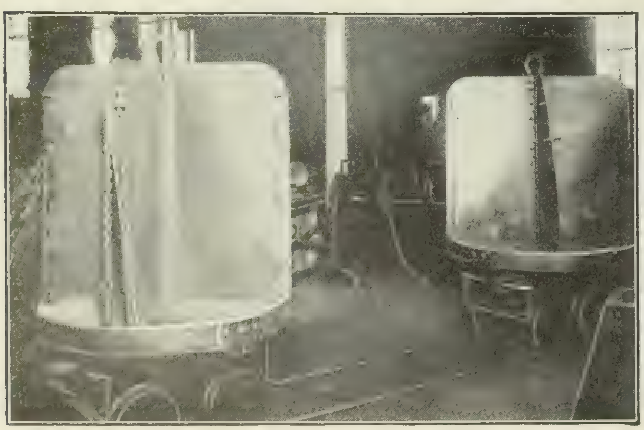


FIGS. 1 AND 2. DRILL-STEEL CARS, AND A DRILL-SHARPENING UNIT

shanks, the No. 3 sharpener being the only one devoted to shanking. Figs. 2 and 4 show the layout of a sharpening unit. The forge is long and low, heating from 15 to 25 steels at one time. The helper starts the steel in the left-hand side of the forge, gradually working it to the right, each steel thus receiving the proper heat and also bringing it into easy removing position.

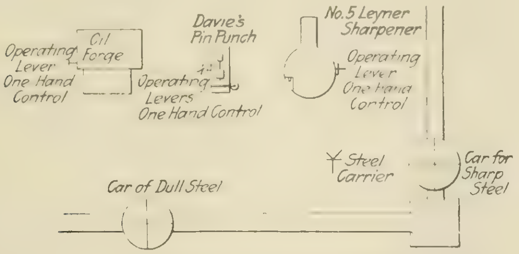


FIG. 4. LAYOUT OF A SHARPENING UNIT

The punching machine (Fig. 5) consists of an air plunger governed by an oil cylinder. The piston rod carries a chuck for holding the punches. A self-centering clamp operated by an air cylinder insures alignment of steel and punch. This punch has increased the sharpening capacity 50%.

Each steel is tested by a blow gun. The blacksmith, while turning the steel up to place it on the car, pushes the shank against the automatic blow gun. This could be done without reversing the steel, but sparks were sometimes blown upon the operator; and as "Safety First" is one of the mottoes of this shop, the blacksmiths are instructed to test the steel from the shank end. Steel is punched, sharpened and blown out in one heat.

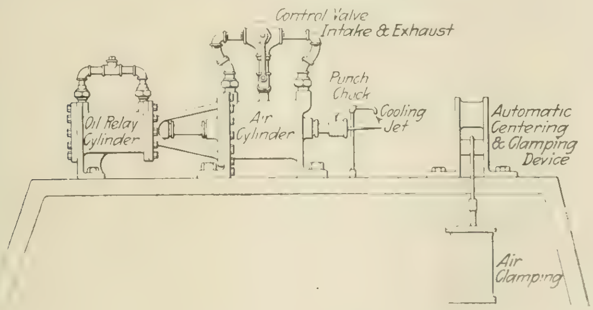


FIG. 5. PUNCH FOR HOLLOW STEELS

Supervision of drill shanks has resulted in reducing piston and drill-steel breakage. Out of about 5000 pieces used, only two to three are broken per shift.

This paper embodies data furnished by Tom Davies, foreman blacksmith, United Verde Co.

Concrete Road Turnouts Poor Practice

By H. E. Bilger*

For both concrete and brick roads the width of 10 ft. has been found by experience to be the most desirable for a single line of traffic. There have never come to my knowledge conditions that would seem to warrant the construction of these single-track roads with turnouts of the same material provided at convenient places along the line.

Where the concrete road is selected in preference to gravel or macadam, it is usually because of the existence of more or less motor traffic. Considering the desire of the motorist always to be hurrying along and the general failure of legislation to regulate this traffic in rural territory, it is apparent what difficulties would be encountered in attempting not merely to retard, but to stop a motor vehicle long enough to make a turnout for another vehicle to pass.

Rather than use the turnout form of construction it has been considered better to employ for single-track roads the use of continuous gravel or macadam shoulders 3 or 4 ft. wide on each side of the pavement. These shoulders are built only 4 or 5 in. in depth and without sprinkling or rolling, as rolling such narrow widths is impracticable. They consist essentially of a certain amount of gravel or crushed rock placed and leveled off without being carefully worked into a pavement.

Within a comparatively short time the action of traffic and the elements work the material into fairly satisfactory metal shoulders. This form of construction seems practicable and economical, particularly where there can be found along the line of the improvement local materials suitable for the shoulders, although not satisfactory for the concrete pavement.

If it were practicable to keep the speed of motor traffic down to about 20 mi. per hr., the 9-ft. rigid road would be almost as satisfactory as the 10. The fact is, however, that speeds all the way from 20 to 50 mi. per hr. are quite common on concrete and brick roads in rural territory in the prairie states, and to reduce the width below 10 ft. would increase the hazard out of all proportion to the saving afforded by the narrower width.

For types of roads having a less rigidly defined edge than concrete or brick, as gravel, macadam or bituminous macadam, the width can with equal safety be about 1 ft. less than that of the rigid type with only earth or cheaply built metal shoulders.

Under conditions where it is imperative that the initial cost be kept at the absolute minimum I personally would suggest the construction of a 9-ft. concrete road at one side of the center of the graded roadway. There should be at least a 3- or 4-ft. earth shoulder on one side of the concrete and about a 6-ft. gravel or macadam shoulder on the other, with a 3-ft. earth shoulder beyond, thereby providing a graded roadway having a total width of 22 ft.

By this form of construction the earth shoulder first mentioned would serve chiefly as a safety feature, practically never having any traffic and requiring no maintenance other than mowing down the growths. The 6-ft. gravel or macadam shoulder would afford a width sufficient to be constructed properly as a standard road, and it could be maintained more economically than the same square yardage in two 3-ft. strips. It would serve the turnout traffic, as well as favor a much safer motor traffic.

Many miles of 10-ft. concrete and brick roads have been built in Illinois with only an earth shoulder some 6 to 10 ft. wide on each side. The 18-ft. roads are always built with earth shoulders, each usually having a width of from 3 to 6 ft. If at least a 2-ft. shoulder is not built, the outer 12 to 18 in. of the pavement is of no avail for traffic since vehicles cannot travel out to the very edge of the concrete. As earth shoulders are much cheaper per square yard than concrete pavement, I can see no conditions that would warrant the construction of these roads without shoulders unless a raised curb were used.

*Road Engineer, Illinois State Highway Commission, Springfield, Ill.

The Miami Valley Flood-Protection Work

IV—Study of Retarding-Basin Operation

Necessity of Predetermining Frequency and Extent of Basin Flooding; Methods of Calculation of Storage for Known Floods; Flood "Routing" for Past Quarter-Century; Quick Recovery of Basin System; No Summer Flooding

The five great retarding basins of the Miami Conservancy District, though designed with sole regard to their service in the largest possible floods, will also operate in other floods. Moderate floods are relatively frequent; and therefore, though their effects are of less amount, they have a vital bearing on the operating value of the project.

It has been stated, with truth, that a flood little more than half the volume of that of 1913 would do practically the same amount of damage in the Miami Valley cities. A similar statement holds for Columbus, where the Scioto flood of 1916, less than one-third as large as the 1913 flood, came close to the levee tops—and with a little additional volume would have again swept the west side disastrously. Under these conditions the certainty and degree of control which the basins exert on such moderate floods must be known, especially with a view to estimating the relative benefits which different parts of the territory protected only by the retarding basins will receive.

Primary questions on the functioning of the system are such as these: What effect will the basins have on a flood like that of 1913? How large will be the river flow at different points, and where (if anywhere) will the water go out of its banks? How large an area in each of the several basins will be flooded, and how long will water remain on the different parts of this area?

Similar questions asked with respect to floods of a magnitude recurring once in ten years, or once in five years, on the average, are still more important. The answers will determine, for example, what use can be made of the 35,000 acres of good farm land embraced in the basins. If the average annual flood submerges, say, 3000 acres of this territory, and if this is more likely than not to happen in the growing season, then the 3000 acres will be idle land, of little value.

Even questions of strictly engineering character, concerning planning of the works, are involved. In order to compare the cost of different plans of flood control, consideration must be given to the relative losses in land rendered untillable by the frequency of flooding. So also

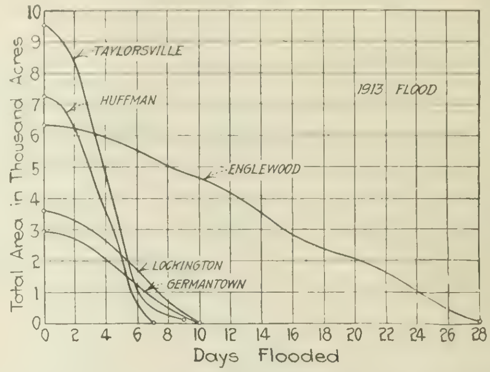
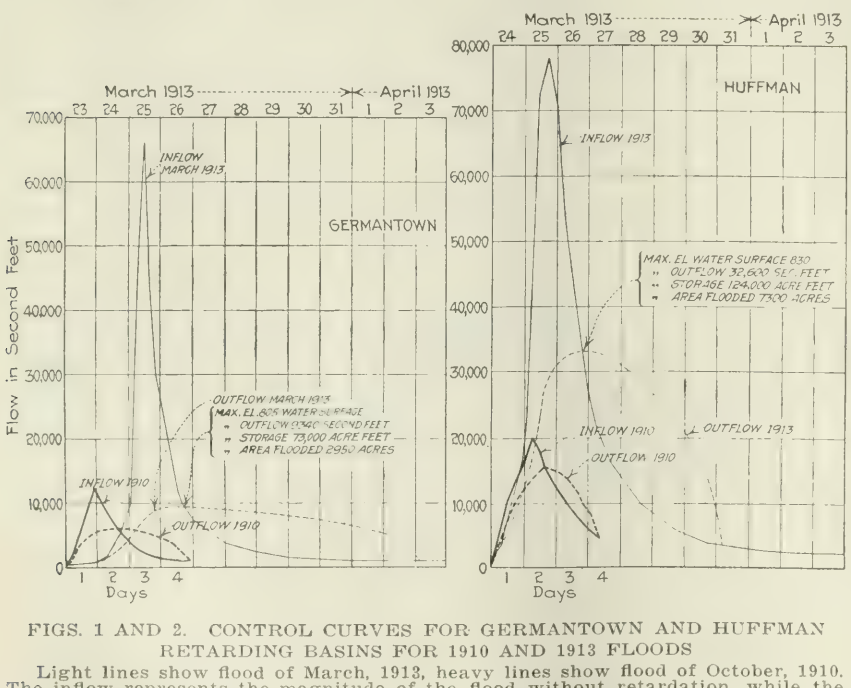


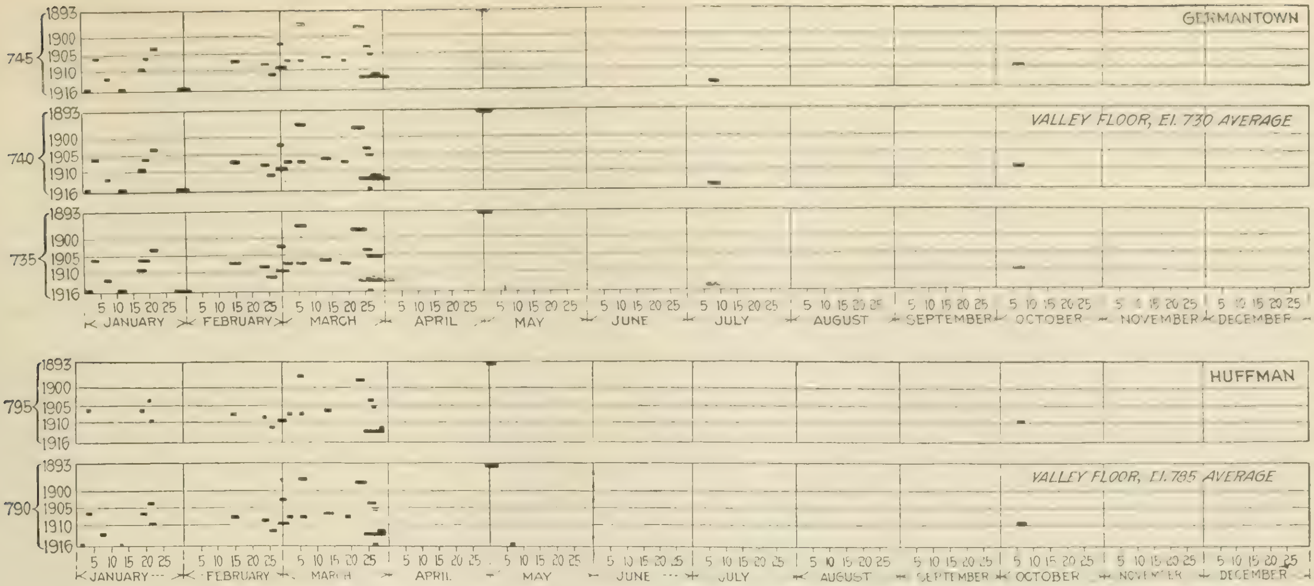
FIG. 3. CURVES OF AREA AND DURATION OF FLOODING IN THE BASINS FOR FLOOD LIKE 1913

the value of a plan will depend partly on the degree of protection from annual floods given to agricultural lands in the valley bottoms below the basins. The height to which ordinary floods will rise in the retarding basins may affect the location and height of drift-catching devices, and may have some influence on the necessity for railway and road relocations. The "recovery" of the flood-control works after a flood—that is, the quickness with which the basins empty themselves and return to normal conditions—is an important factor in defining the security of the system in case of floods in sequence. These questions were answered by a graphical study of basin operation for all the floods whose data are fairly well known. Records were found for all the floods of 24 years, 1893 to 1916, and the study was carried through for each of them. The flow curve of each flood at various points along the river was known, or could be approximated from the data of the river stage records. This curve, for a point at one of the retarding basins, represented the inflow into the basin. In the case of the Taylorsville basin, which is affected by the Lockington basin above, the inflow curve had to be drawn by first finding the Lockington outflow and adding to it the normal (unretarded) flow from that part of the drainage area which lies below Lockington. The rate of outflow from the basin in a flood depends on



FIGS. 1 AND 2. CONTROL CURVES FOR GERMANTOWN AND HUFFMAN RETARDING BASINS FOR 1910 AND 1913 FLOODS

Light lines show flood of March, 1913, heavy lines show flood of October, 1910. The inflow represents the magnitude of the flood without retardation, while the outflow represents the size to which the flood would have been reduced if the retarding basins had been in existence



FIGS. 4 AND 5. TOTAL FLOODING DIAGRAMS FOR 24 YEARS, 1893-1916, HUFFMAN AND GERMANTOWN BASINS

the height to which the basin is flooded. This height in turn depends on the volume stored, which is the difference between the inflow and the outflow. Thus the quantities involved are inter-related. The problem of computing the rate of outflow had to be solved by trial and error.

The calculation was carried out in the form of a tabulation containing in parallel columns the values of inflow rate, outflow rate, storage increment, depth of water and area flooded, for successive time intervals. The inflow was read directly from the flow curve. Assuming then a certain rate of outflow, the difference between inflow and outflow gave the rate of storage, which multiplied by the time interval gave the storage increment. Adding this to the previous storage, if any, gave total storage. There was available a previously computed table for each basin, giving for every foot of storage depth the quantity stored and the area of water surface, all figured from the topographical map of the basin. Using this table, the depth of water which the total storage at the given time would produce was read, and by referring to discharge-rate values calculated from the conduit characteristics the conduit outflow for this depth became known. If the outflow rate so determined checked with the assumed rate of outflow, the computation verified itself.

When these operations had been carried through for the whole series of time intervals covered by the inflow curve, the result was a table of outflow and storage, from which all further questions could be answered.

Basin-Control Curves

Laying off the inflow and outflow rates on a time base to form a time-flow diagram, curves were obtained that show graphically the effect of the basin in controlling (reducing) the particular flood in question, at points immediately below the basin. Such curves are reproduced in Fig. 1 for Germantown basin and in Fig. 2 for Huffman basin. Both diagrams represent two floods out of the 28 of the past 24 years. The March, 1913, flood is shown because of its great magnitude, while the October, 1910, flood is shown as a typical dry-weather flood—one whose effects might be important with respect to farm operations.

It will be seen that the outflow curve reaches a maximum where it intersects the inflow curve. The area between the two curves at the left of the intersection represents the maximum storage. How the basin lowers the flood peak and flattens it out is obvious at first glance. The outflow curve is the reduced river flow below the basin. By adding to it the tributary flow coming into the river at points farther down, a complete picture of the controlled flow is obtained, and it is then possible to make calculations of overflow, required channel enlargement, etc.

Diagrams of Basin Flooding

The table used in plotting the control curve also furnished data for a curve of area of basin lands flooded. Such curves were first plotted on the same time base as the control curve and then, by using the horizontal intercepts of the first curve as abscissas of a second, the relation between area flooded and number of days' duration of flooding was represented graphically.

The duration-of-flooding curves for all five basins for the 1913 flood are grouped in Fig. 3. They bring out the fact that the retarding influence of the basins upon this particular flood ranges from 7 days to 28 days. Englewood basin has by far the longest service, while the other four have nearly equal times of emptying. It is interesting to observe, however, that the two largest of these four basins empty most rapidly, although at peak storage they flood the most land. The relations shown by these curves are not the same for different floods, however. A single diagram like Fig. 3 is therefore not a safe basis for generalizations.

The area-time curve, from which the duration-of-flooding diagram was derived, furnished the data also for an important chart quite different in character. This is the frequency-of-flooding diagram, or, as it was named from its appearance, the pianola diagram (Figs. 4 and 5).

Frequency of Flooding During Past 24 Years

Nearly 40,000 acres of land, of which a large part is excellent farming land, lie back of the dams below their spillway levels. This land is worth probably from $3,000,-000 to $5,000,000, and its annual producing power may be placed conservatively at $500,000. The Miami region ought not to be deprived of this large producing territory or needlessly taxed by so large an annual loss. There was much apprehension in the valley over the effects of the

flood-control project in laying idle these agricultural areas, and it became an important issue in the prolonged Conservancy Court hearing on adoption of the plan.

The Conservancy District intends to buy outright as much of the basin lands below spillway level as may be necessary, in order to eliminate questions over continued occupancy, as well as dispute and litigation over the value of basin easements. However, this does not reduce the necessity for preserving as much as possible of the productive value of the basin lands.

By charting the frequency of flooding in the most comprehensive manner that could be devised a remarkable and in all respects reassuring picture of basin conditions was secured. Figs. 4 and 5 reproduce the charts for Germantown and Huffman basins, the one typifying the basin with relatively small outlets, the other the basin with large outlets (Taylorsville and Huffman). Only the lower stages are covered by the reproduced charts, although the originals were carried up to the maximum storage.

There were only four dry-season floods during the entire 24 years; the fourth is barely visible in the lowest line of the Germantown chart, Fig. 4. During the entire period only two floods occurring in the early growing season would have submerged any material part of the valley bottom. Since these two include the 1913 flood, whose probable mean recurrence interval has been estimated as more than 150 years, the frequency of flooding is even less than the chart indicates. The lowest basin lands will not be submerged on the average oftener than once in 15 years during the months of April to September inclusive. At the higher elevations the flood effects decrease rapidly.

The relatively frequent winter and spring flooding is expected to have no effect on agricultural use of the land, or, if any, a beneficial effect. The opinions of experts and experience in the frequently flooded bottoms near the mouth of the Miami joined in showing that winter or spring flooding is likely to increase the fertility of the land. For this reason the middle portion of the charts, covering the growing months, is most significant.

The Basin-Recovery Curve; Floods in Sequence

To determine how soon after a flood the basins would again be in normal condition it is sufficient to refer to the control curves, such as Figs. 1 and 2, from which the time when the control ceases—that is, when storage is discharged—can be read. But the amounts of storage capacity available at various times before the complete emptying are not evident. To show these amounts the curves represented by Fig. 6 were drawn.

These curves, derived from the data given by the control tabulations, show percentage of basin capacity left empty at varying periods of time after peak of flood. Fig. 6 is for the Huffman basin and the 1913 flood, the largest on record. Even at peak storage about 25% of the spillway-level capacity would remain empty. Two days later no less than 60% of the basin capacity would be available to receive a following flood, and in four days after peak stage the entire capacity would be available.

This study is important mainly because so little experience is at hand concerning the possibility of two flood storms occurring in quick succession. Conceding such possibility for storms less than that of 1913, the duplication of a 1913 storm within a week appears quite impossible. Yet, the curves show, even in such a case the system is safe (and that without trenching on the reserve capacity, above spillway level). In addition, the recovery curves have bearing indirectly on the question of basin functioning in a storm of more than three days' duration.

To summarize in brief a few of the results of this basin study, the following approximate statements may be made: Ordinary summer floods will go through the two large basins (Taylorsville and Huffman) without even filling the conduits and with but momentary wetting of the low bottoms close behind the dams (not over 200 to 400 acres). In the other three basins the summer floods will produce material storage. It follows that ordinary

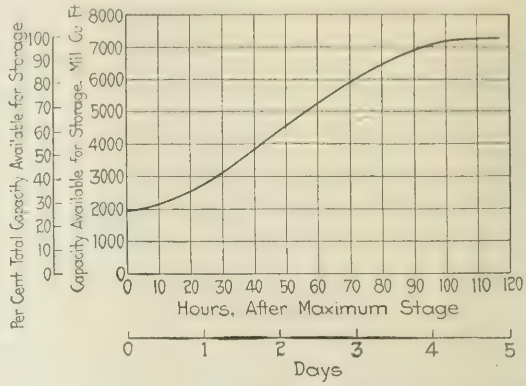


FIG. 6. RECOVERY CURVE FOR HUFFMAN RETARDING BASIN (FOR FLOOD LIKE 1913)

small floods are subjected to but little control at Huffman and Taylorsville.

The average five-year flood (fairly well represented by the 1910 flood, see Figs. 1 and 2) will produce considerable storage in all the basins and therefore will be reduced in stage throughout the valley. The average 25-year flood will be reduced very materially by basin retardation. For both the 5- and the 25-year floods, therefore, farm lands in the valley below, where no channel enlargement is done, will derive benefit from the Conservancy works, while they will get little or no protection against the normal annual flood.

Kenneth C. Grant had charge of studies of action of retarding basins during floods and directed the preparation of practically all the tables and diagrams referred to in this article; A. B. Mayhew made numerous studies of balancing various reservoirs in a harmonious system; Barton M. Jones developed general methods for determining requisite spillway capacities for any set of conditions.

In the article "Dams and Outlet Problems," the third article of the series, printed last week, the following should be *substituted* for the last paragraph:

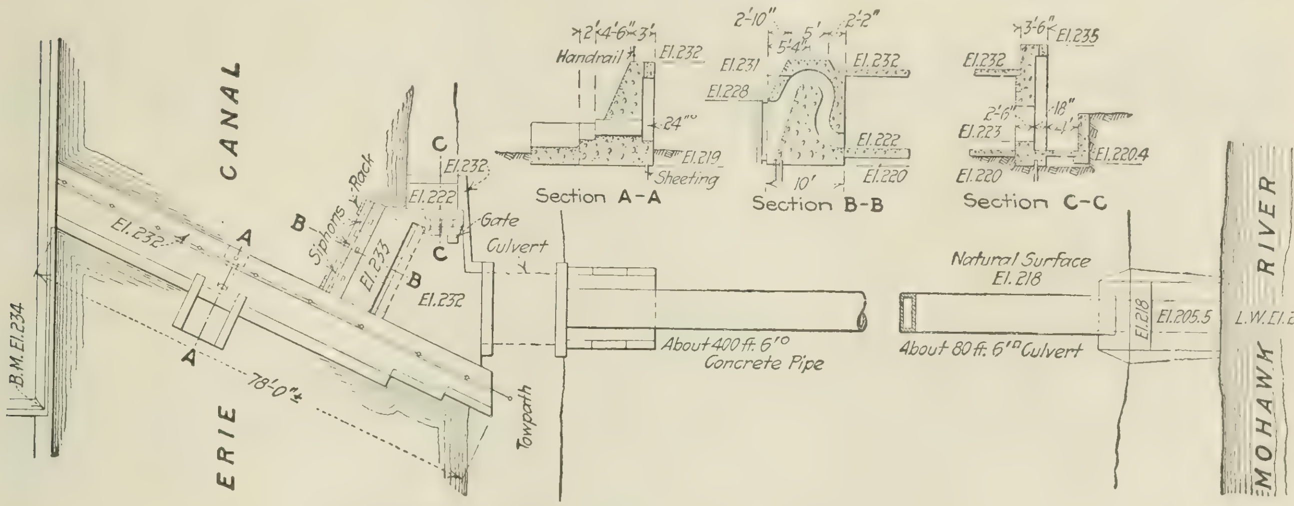
A considerable number of engineers exercised independent responsibility in working out the details of different portions of the designs. The final results were brought together under the general supervision of Charles H. Paul, Assistant Chief Engineer, and S. M. Woodward, Consulting Engineer. J. S. Kimball had charge of channel improvements throughout the ten cities and towns involved. Walter M. Smith, Designing Engineer, had charge of design of dams and related structures. R. M. Riegel worked out the experimental investigation of the hydraulic jump and the details of design of the combined outlet conduits and spillways. O. N. Floyd had charge of plans for railroad relocations and changes to other public utilities. H. S. R. McCurdy made studies of subsurface conditions and conducted investigations and tests of materials available for foundations, embankments, etc.

Siphon Spillway at Schenectady

By Ralph B. Allen*

An interesting siphon spillway for automatic water-level control has recently been completed for the General Electric Co., at Schenectady, N. Y. These spillways are located, as shown by the accompanying sketch, at a dam that has been built across the old Erie Canal, adjacent to the General Electric property, the impounded waters to be used for condensers for that company.

After several studies of different types of overflow spillways it was determined that siphons would be more efficient and economical, and that better results would be obtained as the opening to a discharge pipe line, which was necessary, would be entirely covered so that no refuse could enter. On the other hand, an overflow spillway of the required capacity would necessitate a prohibitive length and would necessarily have to be uncovered.



SELF-PRIMING SIPHON SPILLWAYS AT SCHENECTADY, N. Y.

The top of the dam is at El. 232. The water surface above is to be maintained at El. 231, with very little fluctuation. This is accomplished automatically by the three-siphon spillway, each siphon having a capacity of about 80. cu.ft. per sec. at time of high water in the Mohawk River, when the minimum siphon head will be 4 ft.

The section of each siphon spillway required for the necessary capacity is shown in the accompanying sketch by the section B-B, each of the three siphons being built in the masonry and having a crown section of 4 ft. wide by 1 ft. 9 in. deep. Partition walls 1 ft. thick divide the siphons. As will be noted, the intake opening is placed well below the water surface to avoid the entrance of ice or débris, and is further protected by a timber screen. The discharge end is constructed as low as possible in order to obtain all available head. The crown is built above the required water level.

The siphon is controlled by the 4x9-in. vent, which is located slightly below the required water stage. As the water above the dam rises and submerges the vent, so that no air may enter the siphon, the water spills over the crown and with this overflow the air is carried out. As the air becomes rarefied in the siphon, the water rises higher in the crown than the water surface above the dam. The crown becomes completely filled almost as soon as overflow occurs. This primes the siphon, siphonic action takes place, and a rapid flow commences. This flow continues until the water surface is drawn down to below the vent; and when a sufficient quantity of air is admitted, the siphon breaks. The break is not complete at the instant of the entrance of air, but is gradual, as the admission of a small quantity of air simply decreases the flow.

When this siphon was completed, the theory of self-priming was entirely borne out (as it had been before at the Champlain Canal siphon spillways and earlier in Europe[1]); action took place almost the moment the vents were submerged, and ceased when the water was drawn down to the proper elevation.

The water drawn above the dam by the siphons is discharged through a 5-ft. reinforced-concrete conduit, under a small head, to the Mohawk River. A 24-in. gate valve was installed in the dam at a low elevation, to allow for necessary flow to avoid stagnation below the dam. A rectangular gate, 54x54 in., was also placed in line with the spillways to discharge directly into the pipe line to permit the complete drawing down of the water.

As will be noted from the sketch, the elevation of the control vents for each unit is slightly higher than the preceding unit, thereby allowing a more constant regulation of the water level. Siphon No. 1 will prime and discharge, about 80 sec.-ft. almost immediately when the water closes the first vent; a rise of 0.1 ft. will prime siphon No. 2, etc., the required flow depending on the number of condensing units in use. At present there is but one condenser installed, but two additional are contemplated in the near future, each requiring 70 sec.-ft. The water surface is thereby absolutely automatically maintained.

The dam and siphons are founded on clay with sheet-piling cutoff. The pipe line is principally of "Lock-Joint" reinforced-concrete pipe, having a 5-ft. inside diameter and 6-in. thickness, and also a stretch of about 80 ft. of 5-ft. square reinforced culvert ending in a head wall, the discharge end of the pipe being placed below the low-water level of the Mohawk River, to eliminate trouble from ice or refuse.

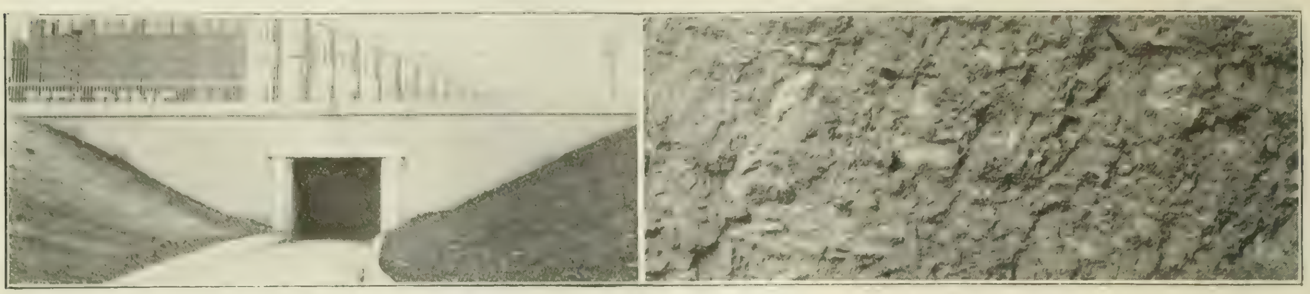
The entire structure was designed by William Russell Davis, Consulting Engineer, Albany, N. Y., for the General Electric Co. The siphon spillway used is patented by George F. Stickney, Albany, N. Y. (designer of the Champlain Canal siphons, the first built in America).

*Assistant to William Russell Davis, Consulting Engineer, 311 Arkay Building, Albany, N. Y.

[1]See "Engineering News," Oct. 30, 1910, and Apr. 20, 1911.

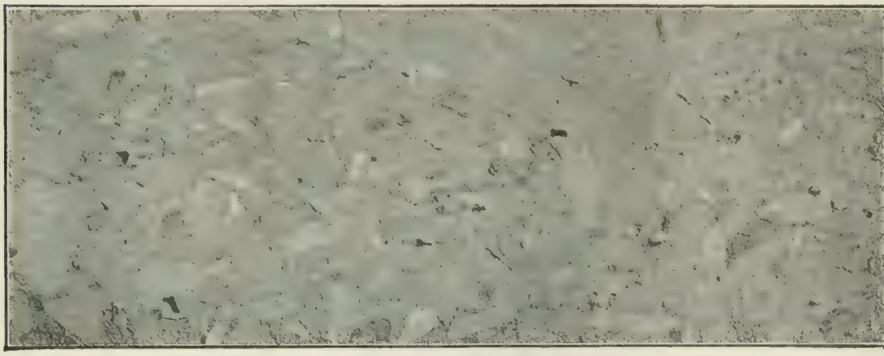
Concrete Finish on Some Cleveland Bridges

On this and the following page are shown recent views of some reinforced-concrete bridges at Cleveland, Ohio, in which special effort was made to obtain pleasing texture and line in the concrete surfaces. In each case a distant view is given of the structure or a part of it and this is accompanied by one or two close-up views showing the detail texture. In addition under each set of views is a description of the structure and of the method followed in the surface finishing. In some of the bridges, also, the cost of this finishing is given. Particular attention might be called to the accentuation of shadow in the details of some of the structures, especially in those shown in Figs. 11 to 15, with the accompanying improvement in appearance over the ornamentation or fine detail decoration somewhat common in concrete bridges, especially in those of monumental type.



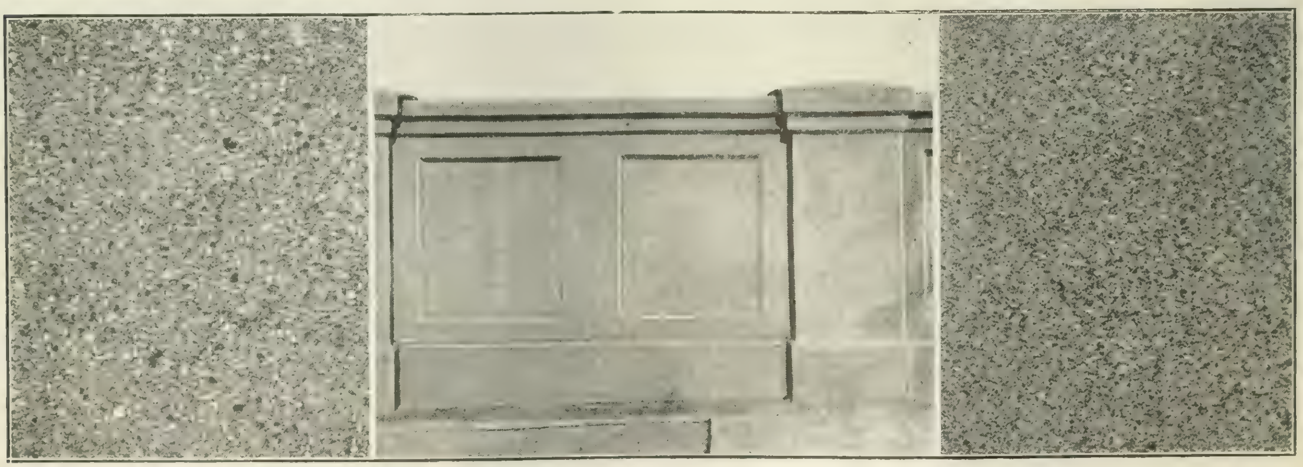
FIGS. 1 AND 2. TUNNEL FOR FOOT PASSENGERS UNDER RAILWAY AT EDGEWATER PARK

Under New York Central R.R. at foot of West 76th St. Side walls were bush-hammered as soon as forms could be removed; that is, from 20 to 30 days after placing concrete. Hammer weighed 5 to 6 lb., had 2½-in. square face, 9 teeth on one end, 16 teeth on other. The 9-tooth face used for roughing and 16-tooth face for finishing. At right is close-up view of bush-hammered surface on the main side wall shown



FIGS. 3 AND 4. CEDAR AVE. BRIDGE OVER DOAN BROOK

One of four posts built in the fall of 1910. One of the posts was finished during the inclement weather of December, when it was necessary to have fire adjacent to allow work to proceed. The following spring the three other posts were finished. Surface finish was obtained by rubbing with carborundum brick except a final rubbing of the panel with cement brick (1 : 2 mortar). The four posts contain 8.1 cu.yd. of concrete which cost $19.91 per cu.yd., including finishing. View on left detail of panel in post, with exposed aggregate of limestone



FIGS. 5 TO 7. FAIRMOUNT ROAD BRIDGE OVER FOUR-TRACK RAILWAY LINE

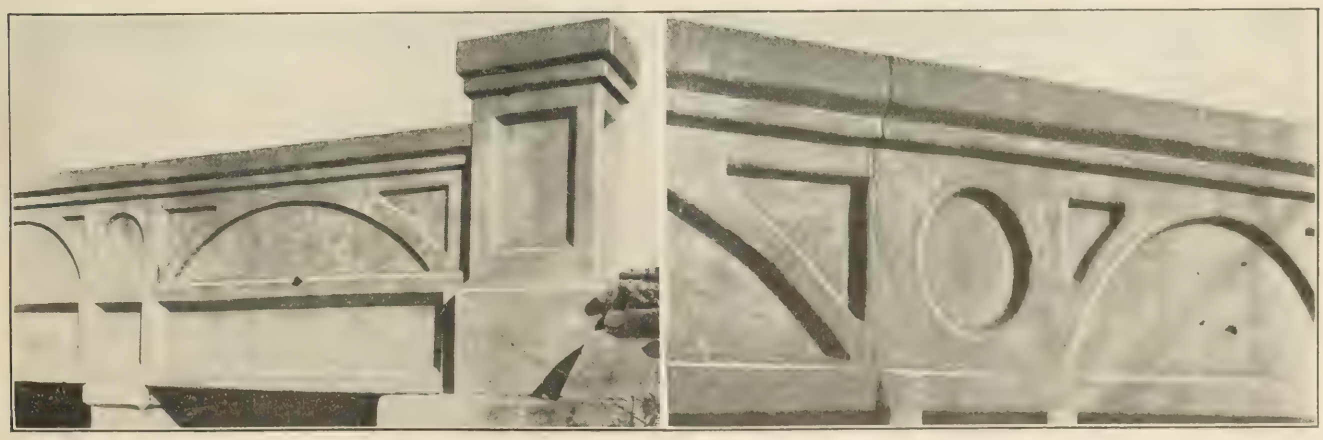
Reinforced-concrete railing on structural steel bridge incased in concrete. Aggregate of railing is screened gravel 1 : 2 : 4, which was bush-hammered with pneumatic tools. Mortar (1 : 2) then was applied and rubbed to finish with wood floats. Work was completed in November, 1912. Pneumatic bush-hammering cost $0.1175 per sq.ft. without overhead. Cost of mortar coat was not kept separate from other items of surface finish. The appearance of the surface finish is excellent and shows no signs of deterioration. View on left is detail of coarse sand finish and on right of fine sand finish

FIGS. 8 TO 10. SHAW AVE. BRIDGE CARRYING TWO-TRACK RAILWAY

Bridge is through plate-girder with floor incased in concrete and girders hidden from street. View on right is an enlarged detail of the bush-hammered surface of the railing, which is 1 : 2 : 4 concrete with screened gravel as the aggregate. View on left is of the panel in the wing finished by bush-hammering with air tools. The concrete is a 1: 3: 6 sand and limestone, in which the larger stones were spaded back from the face. Work was completed in September, 1912. There were 3420 sq.ft. of surface bush-hammered at a cost of $0.0621 per sq.ft.

FIGS. 11 TO 13. EAST BOULEVARD BRIDGE CARRYING TWO RAILWAY TRACKS

The matrix of the arch over the bay of the belt courses and in the panels is crushed red granite from Pictou Island in the St. Lawrence River. Screenings made by the crusher in preparing coarse aggregate for panels were used in belt courses and arches over bays. The surface finish was about 2 in. thick, mortar of which was colored with iron oxide. All surfaces were bush-hammered except the panels where the aggregate was exposed by picking out the mortar with pneumatic tools. View on right is detail of this surface. It was the intention to expose the aggregate in the bays by use of brushes, but sudden coming of cold weather rendered postponement necessary. Smooth-rubbed surfaces were obtained by applying 1 : 2 mortar to the bush-hammered surfaces, then rubbing with carborundum brick. The appearance of this structure is more pleasing than when finished in October, 1912. When just finished, the smooth surfaces were a light pink, but with weathering contrast in color has disappeared. View on left is detail of decorative archway



FIGS. 14 AND 15. MAYFIELD ROAD BRIDGE CARRYING FOUR RAILWAY TRACKS

Structural steel bridge, through plate girders between curbs. View on right a detail of portion of facia. The concrete, a 1 : 2 : 4 mixture in which screened gravel was the aggregate, was applied directly upon the outer girder. The entire surface was bush-hammered with pneumatic tools after the concrete had become thoroughly hard. Sand finish was applied same as on Fairmount Road (Figs. 5 to 7). The area bush-hammered was 8280 sq.ft. and cost $0.1084 per sq.ft. Cost to apply mortar coat was not kept separate from other items of finishing. Work was completed in 1912 and is in as good condition as when finished. Note good shadow effects in detail

Early Experience with Concrete Paving

Last year, the Portland Cement Association estimates, nearly 25,000,000 sq.yd. of concrete street, road and alley pavement was constructed in this country—equivalent to almost 2500 mi. of 18-ft. road. This is nearly three-quarters of the total amount of concrete pavement laid previous to Jan. 1, 1916, which brings home how new this branch of the paving industry is and what great strides it has made in the last two or three years.

Few realize that concrete paving has a history of nearly half a century, and that its present success is in no small measure due to the same changing traffic conditions which have thrown waterbound macadam into the discard. For it is unlikely that concrete paving would ever have been developed to its present popularity had traffic remained chiefly of the horse-drawn variety.

Knowing that portland cement concrete has been used for pavement foundations since about the middle of the last century, one's curiosity is aroused to know if it was not at some early date proposed for pavement surfacing, and why it was so long coming to its own.

Early English Concrete Roads

The original source of much of our present literature on pavements is a lengthy discussion before the Institution of Civil Engineers in April, 1879, on "Street Carriageway Pavements." At that time wood-block and sheet-asphalt pavements were coming into extensive use and the improvement of stone-block pavements by use of concrete foundations was regularly practiced in London and the other great cities of Europe.

Discussing concrete as the suitable foundation for wood-block pavement, Joseph Mitchell, of Inverness, said that he "was convinced that for secondary streets concrete alone, if properly laid, would make a perfect and durable road; but with the cement hardening so quickly, it required careful manipulation.[1] Mitchell had previously patented (1865) a two-course concrete pavement of a 1 : 1½ : 4 mix, which probably was one reason for its not being more widely adopted at that time.

Another reason against its adoption very likely was that these early experiments proved unsatisfactory because of the inability of the concrete to withstand the abrasion of heavy horse-drawn traffic. Another engineer, J. Price, had this in mind during the same discussion when he described a type of concrete pavement which he had developed and used to a small extent. In this present day of widespread use of concrete paving, Price's early experiment may still contain a helpful suggestion.

His pavement consisted of a thick bed of portland cement concrete. While still in a soft state it was paved on top with angular pieces of granite, or other hard stone, set with the flattest face upward, fitted into each other at random. This he called a "breccia" pavement from the geological term for angular conglomerate. It possessed the bearing strength of concrete with the abrasive resistance of the granite. The concrete filled the irregular interstices between and around the stones and formed a solid mass. The method of construction was to board off a section of concrete and before it hardened workmen placed the stones and bedded them by hand, working from a bridge.

[1]Minutes of Proceedings of Institution of Civil Engineers, 1879.

Following these isolated early experiments, most of the development in concrete pavement seems to have taken place in the United States. The first use of concrete for paving here was for sidewalks, then for alley pavements, and in 1892 a strip of concrete 10 ft. wide and about 200 ft. long was laid on the west side of Main St. in Bellefontaine, Ohio, being so far as known the first portland cement concrete street pavement in this country. It appears, however, from an article by G. W. Bartholomew, Jr., in *Engineering News*, Jan. 3, 1895, that a concrete pavement was laid in Detroit, Mich., about the same time.

Bellefontaine Has Early Pavement

Much has been made of the fact that the Bellefontaine pavements are still in existence and in fair condition, but it seems that they were model construction in their day. The subsoil is gravel and a 4-in. tile drain was placed under each curb. The pavement was made in two courses, the lower 4 in. being 1 : 4 cement and gravel, the ratio of the gravel or stone to the sand being 2 : 1, or the mix was 1 : 1⅓ : 2⅔, which it will be seen is a richer mixture than commonly used today. The top 2 in. was a 1 : 1 mix, cement and sand or crushed granite to the size of a pea. The pavement was divided into 5-ft. slabs by tar paper joints, the idea being to make the subsurface structures more accessible than with a monolithic pavement. These pavements cost $2.15 per sq.yd., including curbs and tile drains.

The Bellefontaine pavements were inspected in March, 1903, by Prof. F. H. Eno, of Ohio State University, who described them in *Engineering News,* Jan. 7, 1904. He wrote that on the main streets where traffic was distributed there were few signs of deterioration and no cracks of any account, but that on the narrow streets wheel ruts had been worn in the longitudinal joints, as some photographs which went with his article show. The surface was originally rolled with a metal imprint roller in order to give a foothold for horses, but at the end of 10 years these had in most instances entirely worn off.

Following the success of the pavements in Bellefontaine other Middle West cities tried them and concrete became a recognized type of city pavement, although never extensively used until within the last 10 years. Among some of the Middle West towns and cities which have concrete pavements 15 or more years old are Richmond, Ind. (1896), Kalamazoo, Mich. (1896), Logansport, Ind. (1900), and Fostoria, Ohio (1902).

Rochester Pavement Built 25 Years Ago

In 1893 J. Y. McClintock, then City Surveyor of Rochester, N. Y., did some experimenting with concrete as a surfacing for macadam which was then beginning to wear out. The following is an extract from the printed report of the City Surveyor of Rochester for the year ending Apr. 1, 1894:

CONCRETE PAVEMENT—There are many miles of streets where a cheap pavement is requisite and where macadam with trap rock would be suitable except that it seems desirable to get rid of the small amount of mud which is usually present and to have a surface that can be washed clean. To meet this requirement we tried the following pavement on South Fitzhugh St., north of the canal in 1893. The surface of an existing macadam pavement was picked off and a layer of trap rock 6 in. thick in the middle and 2 in. thick at edge of the paved gutters was put on and thoroughly rolled with a

steam roller. After this was done, instead of putting on a binding material and rolling that in as usual, portland cement grout, one of sand to one of cement, mixed to the consistency of cream was carefully poured in, so as to fill all the voids between the broken stone and form a solid matrix to hold each stone firmly in position. The stone was thoroughly wet just before pouring in the grout. One barrel of cement was used to each 8.7 sq.yd. of pavement. After the mortar had set for 24 hr., sand was thrown over the surface and water was sprinkled upon it, and all travel was kept off it for nine days. This has been down eight months and already shows that the size of stone used was too small; it would all pass through a 1½-in. ring. The stones are so small that the calk of a horse's shoe sometimes throws out a stone bodily. I believe it will be well to try this again with stones which will pass a 3-in. ring and will not pass a 2-in. ring. The cost of this pavement was $1 per sq.yd.

Mr. McClintock gives a further record of this pavement in a letter to the editor as follows:

As far as I know, the proposition originated with myself. The impelling consideration came from the fact that I had recently become City Surveyor and macadam pavements had become so unpopular that it required a vote of 15 out of 16 aldermen to pass an ordinance for such a pavement in the City of Rochester, because many miles had been built with soft local stone which would usually wear out so as to be scraped off by the Highway Department the year following construction. I was familiar with what was being accomplished in New Jersey and Massachusetts in the use of trap rock and so making a successful macadam road. Being familiar with the use of cement and being impressed by the possibilities of using portland cement which then had first been reduced to a price warranting its use in highway construction, it was very natural that I should try it as described. I made a communication to the Board of Aldermen, discussing the subject and emphasizing the importance of trying it, and asking them to allow me to try it experimentally in the manner described.

The piece of pavement laid developed irregular temperature cracks and on one portion of it, where the hacks stood in the shade of the court house, the horses would drill holes with their feet in kicking off flies, so that it soon became a question of how the pavement could be maintained. It was some two and a half years after the pavement was laid, when I left the office of City Engineer, as it had then become; and as I understand it, some two years after that—when an overhead bridge crossing the canal in the vicinity of the pavement was replaced by a lift bridge and the approaching grades were reduced—it was deemed wise by the city authorities to cover the new portion of roadway with asphalt, and at that time they also pulled out this short section of concrete and substituted asphalt.

Advisability of Using Old Macadam as a Pavement Foundation

By W. S. Anderson*

Engineers in considering the problem of rebuilding an old macadam roadway with a permanent surface generally insist (although it is not always secured) upon a subgrade of uniform density. To accomplish this, when the width of the new roadway exceeds the width of the old macadam road, is difficult without the expenditure of a considerable sum and causing inconvenience at times to the traveling public. What plan of procedure, then, is most logical?

First, it must be granted that if the subgrade adjusts itself to any extent in any manner whatsoever or if the center of the roadway is well compacted and the sides are less dense, cracks will occur in the pavement surface regardless of the type of pavement or kind of material used. To eliminate cracks, the subgrade must be made uniform in character by scarifying and loosening the old macadam foundation and by a uniform respreading and rolling of the excavated material over the subgrade.

Such a procedure does not necessarily insure a uniformly compacted subgrade, but approaches it within practical limits. Its accomplishment will cost considerable money, amounting approximately to from $800 to $1500 per mi. when the surface profile of the new road is made parallel to that of the old macadam road or when cuts or fills do not exceed about one or two feet.

Merely to remove the crown of the old macadam road and to spread and roll this material over the full new width would reduce this cost approximately 70%, which saving could be used to maintain the cracks that might subsequently occur in the pavement.

Is it wise to allow such an argument to sway one's judgment in the establishment of a uniform plan of procedure? It is not, for the simple reason that conditions such as depth of foundation, degree of compactness, and others as well, vary so greatly on each particular job that a definite recipe for all cases cannot be suggested.

Each job must of necessity be studied separately, with the one idea in view of building the best pavement possible commensurate with obtaining the largest mileage for the money available. When the cost of scarifying or loosening the macadam foundation is not too great a proportion of the total cost of the pavement proper, such precautions should be taken. By so doing, a large number of the cracks that would otherwise occur will be eliminated.

In addition to cost, the question of convenience to the traveling public is all-important. If the road in question is urgently needed by the public and if its use during part of the construction period would be of financial value and of convenience to the community, the plan of not scarifying or removing the macadam foundation deserves consideration. If the foundation is removed or destroyed, the old road will be unfit for travel during the period of construction, and ruts and ridges will be produced by the vehicles.

Ruts in subgrades are of considerable detriment to its uniformity in that each rut becomes more compact than the material adjoining and is then later filled with less compacted material that will act as a small individual reservoir for subsurface water. Under such conditions it would be more feasible and valuable to construct the permanent pavement on the old macadam surface with merely its crown removed, the excess material being spread over and rolled in the sides. In conclusion, these thoughts can be summarized as follows:

1. Each job must be studied by itself, and its relation to public service must be given consideration.

2. The economy realized by not destroying the macadam foundation should be weighed against the disadvantages of cracking and disintegration of the pavement surface.

3. The cost and feasibility of maintaining the cracks that may occur in the particular pavement in question must be known or determined within practical limits.

4. When side fills of more than one foot in depth are required to obtain the new road width, the macadam foundation should in all cases be loosened or scarified to a depth of not less than one foot and the material spread uniformly over the entire width of the subgrade.

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Sewage Treatment as Seen by the Layman is illustrated in a ludicrous manner in a Chicago paper whose staff correspondent, reporting a visit to the experimental sewage-treatment plant at Decatur, Ill., says: "The sewage flows in at one end of this machine and comes out at the other end divided into grease, ammonia potash, fertilizer and water."

New Skylight Design for Trainshed at Lackawanna Station, Buffalo

By A. E. Deal*

After several years of continual annoyance with wire-glass skylights on various railroad structures, principally on the Hoboken and Scranton trainsheds of the Bush type, the Lackawanna R.R. determined to avoid, if possible, the recurrence of the trouble on the new Buffalo trainshed. Skylights for a Bush shed must be built in a nearly horizontal position. Whether the difficulty in withstanding the conditions is due to the glass being insufficiently supported or whether glass will naturally crack as a result of internal stresses when laid horizontally in spans of 5 or 6 ft., the fact remains that the old type is not satisfactory, both on account of the leakage through the cracked glass and of its general unsightly appearance resulting from deposition of sediment from locomotive smoke. These skylights cannot be cleaned, because the construction is not strong enough to stand it. The cost of repairs is altogether too much. There is about 90,000 sq.ft. of skylights in the Hoboken trainshed, built in 1905, which must be replaced in a few years.

When the question of the Buffalo trainshed skylights arose, specifications were drawn for the old metal wire-glass type. This specification avoided having any steel exposed to the weather; that is, the steel had to be lead coated or monel metal sections, and further, the flashings specified were to be of monel metal, which is practically weatherproof. Bids were secured, and it was found that this unsatisfactory type would cost at least 50% more than the concrete type.

The reinforced-concrete construction was therefore decided upon, using small glass squares (6 or 7 in.), which is merely an adaption of the concrete vault-light construction employed frequently for lighting beneath sidewalks. The idea of applying this construction to skylights was adopted for the Kansas City Terminal Ry. trainshed. Several of the manufacturers of concrete skylights have a product in which part of the reinforcing steel is exposed to the air. Those types were eliminated from consideration, and three quite different styles of comparatively the same cost were selected for investigation. The railroad had sample slabs constructed by the manufacturers and fully tested at Columbia University for strength and lighting efficiency. On a 5-ft. span one type carried an equivalent uniform load of 2058 lb. per sq.ft., while the one selected produced 619 lb. per sq.ft.

*Bridge Engineer, Delaware, Lackawanna & Western R.R., Hoboken, N. J.

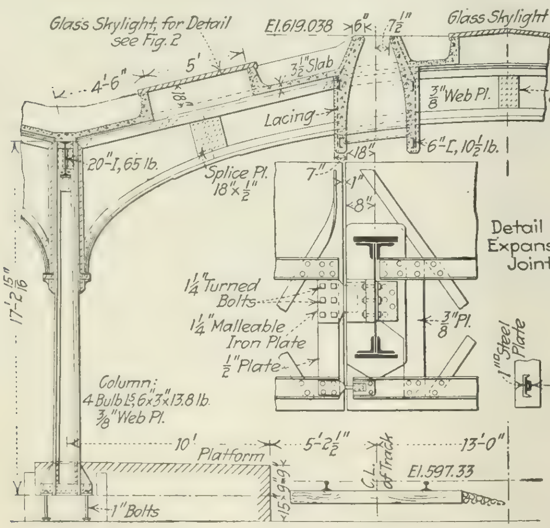


FIG. 1. HALF-SECTION THROUGH TYPICAL TRAINSHED BAY

The trainshed that was designed and that has since been built is shown in the accompanying drawings. It consists of arched girders spanning two tracks and carrying continuous reinforced-concrete roof slabs that are opened over the tracks for the smoke-vent trough and over the platforms and the midtrack space to carry glass-panel skylights. The platform lights have a single slope and, as shown in Fig. 2, are in sections 22 ft. 8⅛ in. long, spanning the adjacent arches and 5 ft. 11 in. wide spanning the concrete structure of the opening. Each section is in separated panels, made up of forty 6⅛-in. square glass lights. The midtrack section is similar in design, but has a double slope to fit the peak of the roof.

The concrete in the skylight is mixed in the proportion of one part cement to two of sand, no coarse aggregate being used. The lower half of the slab up to the seat

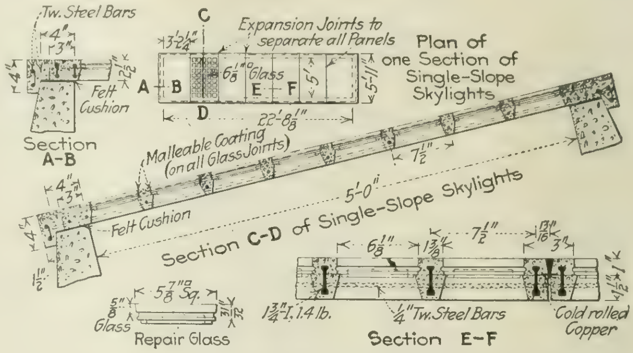


FIG. 2. DETAILS OF THE ONE SLOPE SKYLIGHT IN TRAINSHED

for the glass is precast in the shop of the manufacturer; after setting up, it is shipped to the site, the glass units set in place, and finally the upper half of the slab is concreted. The precasting in the shop permits using molds cheaply and eliminating falsework in the field. The reason for not casting it entirely in the shop is to provide for the copper expansion strip that is embedded in the concrete.

It is considered most important to keep the skylight well above the roof on top of the concrete curbs, so that after a heavy snowfall the skylight will not be covered with snow and slush.

Other salient features requisite to good construction are the facility to replace a broken unit, the proper annealing of the glass and the general neatness of appearance. Units of glass will get broken accidentally, necessitating a convenient method of replacement without injuring the adjacent concrete and without sacrificing its water-tightness. In the adopted type this is accomplished by carefully knocking out the glass, including the encircling convex rib. The glass unit used in replacing is slightly smaller in size and has a groove around its sides. This groove, together with the one left in the concrete by the original unit, is filled with neat cement and the glass forced into position.

To provide against shaling of the glass or chipping of the concrete due to the unequal expansions, the surface of the glass in contact with the concrete is coated with

a plastic cement. In order to avoid internal strains usually inherent and which in time will disintegrate the glass, it was specified that the glass should be thoroughly annealed and allowed to cool 36 hr. in a sealed oven. The strains in the glass are readily detected by the use of the scleroscope; and when strains are present, the glass must be reannealed. Each glass unit is inspected by the manufacturer, and the railroad's inspector checks his work by selecting units at random.

In the illumination tests, which were obtained by the use of a photometer, an interesting and unexpected feature developed in that a plain glass surface permitted better transfusion and more diffusion of light than either a fresnel lens or ornamental under-surface.

The manufacturer and patentee is the American Bar Lock Co., which is guaranteeing the work under bond for five years. The design was made in the office of the writer, under the direction of George J. Ray, Chief Engineer of the Delaware, Lackawanna & Western R.R.

Drafting Room vs. Shop*

Many good machinists secretly believe that they can make drawings the equal of those turned out by the best draftsman that ever strutted through a machine shop—with a little practice. This belief is natural; in many cases it is a just belief. In many cases, though, it is a belief based upon an erroneous idea of what constitutes a draftsman and the nature of his work. "Why," I have heard machinists say, "all a feller needs is a little practice twirling a compass, a little brushing up on arithmetic, and the chance!" Sure! And the most difficult of these is the chance. There is more truth than wisdom in this; but also, there is more to drafting than the mere twirling successfully of a compass and a good working knowledge of Euclid.

Among other things, there are required an infinite patience, not only with the tools themselves but with one's superiors; a willingness to be haunted o' nights that a certain cam will give required results, or a lever in its work clear the frame, or an odd-shaped piece transcribing an odd-shaped curve pass through its cycle correctly and as drawn; and lastly, and more than all else, a Job-like stoicism that will resignedly see a man in overalls in the same establishment step out and upward via the erecting route to a position of comparative ease and big compensation, while you yourself continue on the board because the chief cannot secure a man who knows the work as well as you do.

"Once a draftsman always a draftsman" is a true adage. Given positive knowledge of the inside, few machinists would care to make the change, and every last one of them would refrain from harsh criticism upon discovering petty errors on drawings. Raise the point—sure! But with a little less rasp in your voice, my brothers!

The reason for the long-standing strife between shop and drafting room is simple to understand. It is a very human reason. It lies in the fact that one department catches the errors made by the other. Draftsmen do not get sore when their fellow-draftsmen point out discrepancies in their work. Perhaps this is true because of the understanding that exists among draftsmen relative to their own general difficulties. But it certainly does start the blood boiling in a draftsman when a grinning machinist points out an error in a drawing. If the man only would not grin; or if he must grin, then show by some sympathetic gleam in his eyes that he understands the nature of the draftsman's work and difficulties! He has one on you, and he is proud of it, and he does not care who knows it. But it is not a feeling of brotherhood.

Errors repeatedly creep into a man's work, regardless of how clever and capable and careful he is as a draftsman. An error in figures is one of the most common mistakes that occur in drafting rooms—and the most dangerous. Also, it is the most subtle, the most insidious, the most mysterious of mental accidents. A draftsman may, and generally does, have the correct figure in his mind when he essays to put it down. Somewhere between the act of dipping his pen in the ink and that of setting his hand to the tracing, to establish for all time that figure on the drawing—Zip!—something happens, the mental figure backs up and without reason becomes something else. The mistake is made.

If the draftsman does not detect his mistake when checking his work finally before handing it over to the regular checker—and every draftsman ought to do that—and if the regular checker also fails to catch the error, the thing then rests calmly and easefully in the laps of the gods. Usually these gods take form in the shape of a frowning man in overalls and jumper, with a steel rule in one hand and a pair of calipers in the other. Then, once more, the draftsman is dragged over the coals, if not actually fired—all depending upon the seriousness of the loss. Once more, the old, old strife is given fresh impetus.

Nor can anything be said in excuse for the draftsman who makes a mistake in figures, save that he is human and that for every error he registers he also registers a hundred successes and that, finally, all he has to guide him is his hand and his eyes—never a jig nor a gage nor an automatic machine built to reduce mistakes to a minimum. That long-heralded mistake-preventing drafting machine has not as yet made its eagerly expected appearance. When it comes, draftsmen will all gladly heave a sigh of relief.

A body of sensitive men, as a rule conscientious, always alert, quick as an aspen to sense complaint, ever striving toward perfection in their work—draftsmen are the nerves of the manufacturing business. Inventors and engineers, granted, are the soul; mechanics, the body of the organization. Draftsmen, from the nature of their work, together with their location in the plant, are the veritable nerves of the organization. Any physician will tell you to conserve your nerves as much as possible. Any observer aware of the true conditions in the manufacturing world today will tell you, for the good both of the body of your organization and the soul, to conserve your draftsmen. That, among other things, means to cut out the shop strife.

*Extract from a paper by Charles M. Horton in the "American Machinist."

American Steel Ships Under Construction are now of greater tonnage than ever before in the history of the country, according to the Bureau of Navigation, Department of Commerce. Steel merchant vessels building or under contract to be built in private American shipyards on Jan. 1, 1917, number 403, of 1,495,601 gross tons. During December, 1916, American yards finished nine steel merchant vessels of 24,363 gross tons and made contracts for 29 vessels of 105,120 tons.

Notes from Field and Office

Three special concrete plants—Repairing old wood piles with concrete—How to finish concrete roads—Road-oiling truck developed—Speed checks devised for track approach to drawbridge

Concreting Plants for Culverts and Bridges on the Southern Ry.

Among the dozen or more concrete structures under construction on the relocation of the Southern Ry. in South Carolina are four of such different nature that their several concreting plants form an interesting comparison. These particular structures are a 40-ft. arch culvert at Richmond Creek, an underpass for a road built after the rock-fill was finished, and two bridges, one crossing the Little Chauga River, the other the Seneca.

The Big Culvert—largest under construction on the Southern—is in rather treacherous ground, necessitating very deep sheetpiling for the foundation. This sheeting is wood, 24 ft. long, put down by a 2000-lb. drophammer, sketched in *Engineering News,* Dec. 7, 1916, p. 1092. The concrete plant is shown in Fig. 1. The materials are handled in 4-yd. cars a distance of 2000 ft. from the railway. The stone comes to the siding in drop-bottom cars that dump into bins, under which the 4-yd. cars load.

At the site the cars run up on a trestle over the material bins, which are about 20 ft. above ground. The mixer is directly in front of the bins, while between it and the south-wall forms of the culvert is a 40-ft. tower, from which runs a chute, as shown. Filler stones weighing 5 to 20 lb. are placed in the forms by hand. Men work the concrete around in the base forms. The total yardage is 6000.

Near the Tugaloo River the new line is on a rock-fill. After the fill had been about half completed, it was found that an underpass for a road would have to be put through. The fill had to be blasted and a concrete box built. It was necessary to rush this work, which was commenced alongside the road and outside the fill, starting at the west base line of the future fill. The trenches for the wall footings were in rock, and between these a working platform was erected to carry a baby mixer.

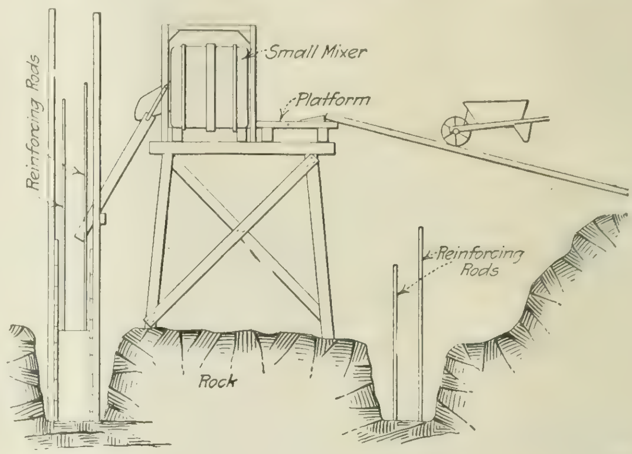


FIG. 2. CONCRETING WALLS OF UNDERPASS THROUGH ROCK FILL

Concrete materials were supplied to the mixer by wheelbarrow over a runway connecting platform and road. (See Fig. 2.)

The Chauga River bridge has square, hollow, concrete piers and two solid concrete abutments. The layout of the concrete plant is shown in Fig. 3. Local sand is used. It is pumped from the creek in the daytime, and the hole thus made in the bottom fills up overnight. This sand is stored in a bin. Granite screenings also are used; stone is brought from a quarry by cars hoisted up an incline to the bins by a cable. Steam is furnished by a traction boiler, which was with considerable difficulty let down the steep hillside to the present location.

The concrete is distributed by a 400-ft. cableway and by a chute from a 40-ft. tower erected alongside the mixer. Rocks of two-man size are placed in the forms, and concrete is run all around them.

The Seneca River bridge is the most northerly structure on the 50-mi. relocation. It is 1000 ft. long and has eight piers and two abutments. The deck-girder spans are 100 ft., and at this season are 80 ft. above the water. The bridge is built right alongside the old crossing (stone piers, trusses and girders), is level and 20 ft. higher.

The pier foundations are 41 ft. 8 in. by 19 ft. 8 in. in plan by from 26 to 38 ft. deep. The excavation was earth and was taken out by hand. A derrick handled the three 3-sided wooden skips that were used. These were filled by men, lifted by derrick and swung down to the river bank, where they were dumped.

The proximity of the existing track of the Southern made the procuring of materials a simple matter. A

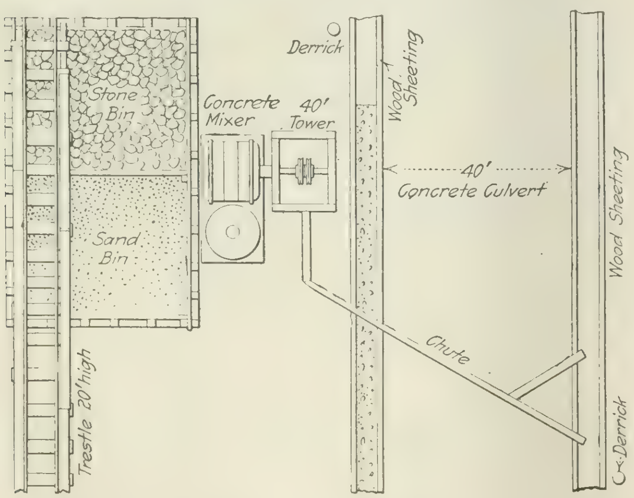


FIG. 1. CONCRETE PLANT FOR 40-FT. CULVERT AT RICHLAND CREEK, S. C.

short trestle was built out from the track and over the slope near the north abutment of the new bridge, and material bins with sloping sides were erected underneath. One of the bins is for coal, and the other is for stone.

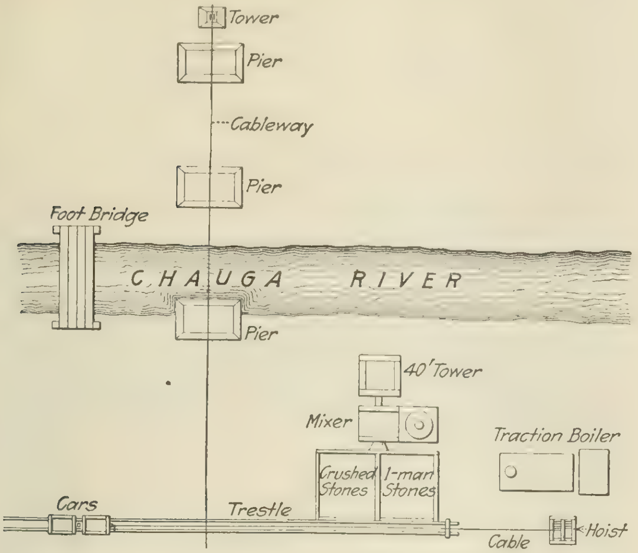


FIG. 3. HOW FOUNDATIONS OF LITTLE CHAUGA BRIDGE ARE CONCRETED

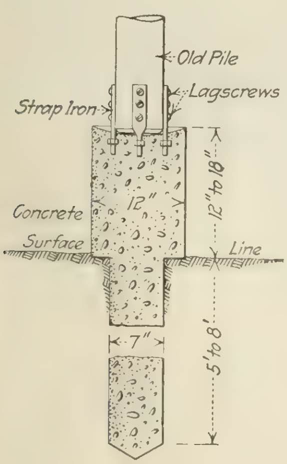
Sand is piled alongside the bins. The cement house is located near the sand pile. Concrete is distributed by a cableway.

The entire 50 mi. of second-tracking is going forward under the direction of R. O. Parsons, Assistant Engineer of the Southern Ry., with an office in Toccoa, Ga. R. F. Ezzell is in general charge of all the construction work on the Southern between Washington and Atlanta, which includes this 50-mi. strip.

Concrete Bases for Old Bridge Piles

By E. V. Moone*

Replacing piling under wood bridges still in fairly good repair as to caps, joists and flooring has been one of the big items of expense in Sedgwick County for years past. The county is now doing a great deal of permanent bridge and culvert construction, but there are still many pile bridges over the larger streams which will have to be maintained for a number of years to come. To reduce this expense we have been putting concrete bases under the piles that have rotted dangerously at the ground line. Replacing a pile always necessitates tearing up the deck of the bridge, removing at least two or three joists and frequently the cap, and sometimes requires falsework for the piledriver. Where we have been able to work on the ground and have had soil that would stand, a repair gang has put in a concrete base, retaining the upper part of the old pile. The chief difficulty has been to get down past the root of the pile. This has been surmounted in most cases either by pulling or digging out the lower part of the pile, or by moving the top of the pile slightly.



BASE FOR OLD PILE

A 7-in. post augur drills the holes to a depth of 5 to 8 ft. Sometimes the holes are reamed out by a "jabbing digger" or a pile spade, which operation allows a mushroom base to be formed. Where shale or a very hard clay subsoil is encountered—even though only a few feet under the surface—we never try to penetrate it; nor have we tried to put down these holes or build bases where there is surface water. On several occasions we succeeded in holding the excavation open with considerable water in the hole, below the surface. In a number of instances where sand was struck below the surface, this sand was thoroughly mixed with a sackful or less of cement, thus forming a base that holds satisfactorily. This construction, however, is never attempted except where the surface soil is firm and hard.

After filling the hole with concrete, a round sheet-metal form, a little larger in diameter than the hole, is placed at the surface. In the form three or four iron straps are placed, so that they will project 8 to 12 in. above the concrete. Each strap is drilled for two lagscrews, and the straps are placed so that the pile slips between them.

The top of the base is pressed down or cupped, using either a wood form or a trowel. This device helps to keep the pile firmly in place. The concrete sets for 48 hr. before the pile, which is secured with the lagscrews, is placed.

A number of bridges thus repaired have sustained heavy floods without damage. Under favorable conditions this method of repair is much cheaper than replacing old piles with new, and it seems to be more lasting.

*County Engineer, Sedgwick County, Wichita, Kan.

Belt Method of Finishing Concrete Pavements Recommended

The canvas-belt method of finishing concrete-pavement surfaces, first used in Wayne County, Michigan, and described in *Engineering News*, Oct. 5, 1916, p. 654, is highly recommended by H. B. Bushnell, division engineer, Illinois State Highway Commission, in the December issue of *Illinois Highways*. What follows is substantially in Mr. Bushnell's words.

If the floating with an ordinary wood float takes place soon after the concrete is struck off, it invites water and stone pockets and a film coating of cement and the lighter impurities in the aggregate, on the surface of the pavement. Late floating insures a better wearing surface and greater freedom from stony pockets, but it is often difficult to insure that the floating is done at just the right time. At the end of a day's run the floater is generally permitted to work close to the strikeboard in order to avoid finishing after dark. After noon hour, in hot weather, the concrete often is found too stiff to float well. A sudden shower may make it impossible to get over the surface even hurriedly with the hand float before it is necessary to cover the pavement with canvas.

Good finishers are scarce. Even with the most experienced men there is a tendency to float spots that are low and flat, due principally to the fact that the finisher concentrates his efforts over a very small area. As the

wearing surface, the most noticeable and one of the most important points in the pavement, is left to an ordinary workman for the finishing touches, the personal equation of this workman is of vital importance to a satisfactory product.

Soon after the canvas-belt method of finishing became known, it was adopted by a road contractor in Kane County, Illinois. Two belts were secured—one 3-ply 8-in. canvas belt and one 5-ply 10-in. belt, both having a composition rubber covering. The concrete was mixed at such consistency that when deposited in a pile it would tend to flatten but would not run at the edges. The concrete was struck off in the usual manner; and after the surplus water disappeared from the surface of the concrete, the 8-in. belt was dragged back and forth over the pavement with practically the same motion as used for the strikeboard. Ridges in the mortar are very noticeable after this first floating.

Just prior to the concrete taking its initial set the pavement is gone over a second time with the belt. This second floating grinds down all the ridges left after the first floating. The second floating leaves a gritty, granular mortar surface entirely free from ridges, flat spots or pockets. It was found that better results could be secured by the use of a 10-in. belt for the second floating because of its greater weight; but if the heavier belt was used for the first floating, it had a tendency to flatten the crown in the soft concrete and to dig into the surface.

During the past few weeks eight other contractors on state-aid work in northeastern Illinois have commenced to use these belts. Some of them have purchased new canvas belts and have had considerable difficulty, due to the stiffness of the material. This defect can readily be remedied by shipping the belt enough to limber it up. The plain canvas belt pulls harder than when covered with rubber, but not to such an extent as to be objectionable.

In Kane County the contractor is placing from 600 to 800 sq.yd. of 18-ft. concrete pavement per day and has no finisher on the payroll. The strikeboard men handle the belt and do the edging. Where armored joints are used, it is necessary to do a small amount of hand floating around the joint, but this is done by the men who place the joints.

This construction feature appeals to the contractor, as it saves him money and the worry of keeping a good finisher on the job; and it appeals to the engineer because of the superior surface and the fact that its operation is nearly "foolproof."

Combination Oiling and Utility Motor Truck Used in Los Angeles

By W. B. Cannon*

A new motor-truck outfit for general roadwork in Los Angeles County, California, has been worked out from a big oil spreader. It was seen that oil could not be spread in bad weather, so flat and dump bodies were provided. This keeps the truck driver busy and prevents the useless expense of a high-priced machine standing idle.

The spreader has a tank and pump unit that can be lifted off after disconnecting the pump chain and loosening a few bolts. The spreading header can then be dropped down, leaving the chassis free for another body. With the other body mounted on a separate frame and suitable hoists provided for lifting the bodies, the shift can be made in 1½ hr.

The oil-spreading body was designed to eliminate the common evils of oiling trucks and to do several new things. First, the tank was covered with asbestos; then, the pump was put inside the tank so that whenever

FIG. 1. LOS ANGELES OILING AND UTILITY TRUCK

the oil was warm enough to spread, the pump would start. The pump was built into a flat casting about 18x24 in. and ⅝ in. thick. This was bolted to the front tank head with a gasket to prevent leakage.

The rotating members are two steel 10-tooth 1½-in. diameter, 5-in. face hobbed pinions. The case projects back into the tank (see Fig. 2). The pump cover is bolted to the front of the case so that the pinions can be exposed and removed without unbolting the case from the tank (after cutting the pump off from the oil if the tank is filled).

Just below the pump chamber is a threeway cock built into the casting, and at the left of the cock is a side outlet that can be connected to the pump, tank or shutoff, by turning the cock. From underneath the cock the suction goes down to a small pump in the front end of the tank. Just above the pump chamber the discharge forms a T, with one outlet coming out through the face

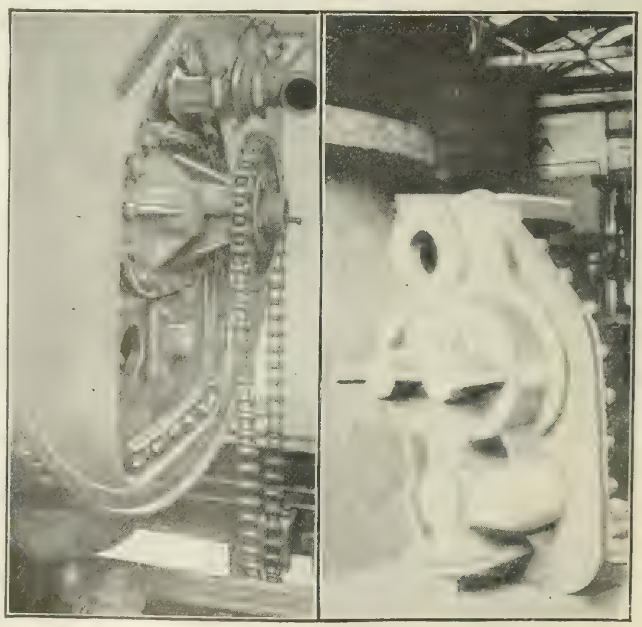


FIG. 2. TRUCK PUMP IN PLACE AND REMOVED

*Route 2, San Gabriel, Calif.

of the pump casting and the other going to the rear of the tank. The pump can take its suction either from inside or outside the tank and discharge into it or outside. At 500 r.p.m. the pump will handle about 200 gal. per min. up to 200 lb. pressure, or the limit of the motor. Power is obtained by a chain from the countershaft in the transmission, which is extended through the case and a cutoff coupling put on.

The pump discharge goes through the back head of the tank, about a foot to the left of the center, and turns down through an angle stop valve. The oil goes down to the left end of the spreader header, crosses over the right and goes up and into the tank through a spring-loaded relief valve. By adjusting this valve the pressure of the oil in the spreader is varied.

The spreader was intended to be as flexible as possible and, by the right combination of nozzle opening, truck speed and oil pressure, will spread from 1/8 to 1¼ gal. per sq.yd., and this in a strip of from 6 in. to 8 ft. wide. The nozzles can (1) all be turned on or off at once, or (2) each half can be controlled separately, or (3) each nozzle can be opened independently until they are all open and then the whole bank turned off at once, or (4) they can be opened at once and closed independently. The cocks are special and carry two nozzles; a 30° turn of the handle in either direction gives full opening. The end of the header is tapped for a 2-in. pipe, and a gate valve with an extension header can be screwed on for oiling shoulders and gutters.

This equipment was worked out by the writer, as chief road oiler of the Los Angeles County Road Department, under Grant Friel, Superintendent of Maintenance, and F. H. Joyner, Road Commissioner.

Crushed Stone Used on Sand Tracks After Tests by Boston Elevated Ry.

Tests of speed-checking tracks have been made by the Boston Elevated Railway Co. since the disaster of Nov. 7, 1916, when a surface car crashed through a drawbridge gate and went over the edge of the draw, drowning 46 people. The company operates eight-car elevated and two-car surface trains over structures in which are draws, and since the accident mentioned the company has felt that automatic signals and train stops or bumpers are not sufficient precautions. Some form of sand track was considered the only available further protection, but tests were desired before construction was started.

A 300-ft. length of track in a storage yard was fitted up as shown in the accompanying sketch and check ballasted in turn with (1) sand, (2) clean, round, beach pebbles and (3) 1-in. crushed stone. The crushed stone gave the best results, reports H. M. Steward, Chief Engineer of Maintenance-of-Way. Cars of any type could be run into the stone at fairly high speeds and stopped with absolute safety, the braking being smoother than emergency application of train brakes. The wheels did not cut through the stone to come in contact with the plank. The trains ran in practically straight lines—in no tests were the cars more than ½ in. out of line.

The broken stone crushed somewhat under the M. C. B. wheels, and the train was raised about 1 in. The impression of the wheels was left in the stone, and the material was not compacted as much as was expected.

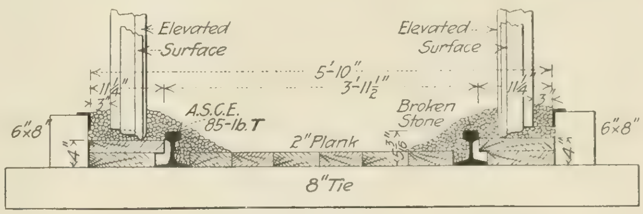
CAR AND TRAIN TEST ON SAND TRACK AT FOREST HILLS YARD, BOSTON ELEVATED RAILWAY CO.

Type of Car or Train	Speeds Previous to Brake Application, Mi. per Hr.	Braking — Ft.	Braking — Mi. per Hr. per Sec.*	Material in Trough	Condition of Material
20-ft. box-car.	11.8	43	2.5	Sand	Dry
20-ft. box-car.	14.8	54	3.2	Sand	Dry
4A3 semi-convertible car	15.0	62	3.5	Sand	Dry
4A3 semi-convertible car.	19.0	98	3.2	Sand	Dry
4A3 semi-convertible car.	19.5	96	3.4	Sand	Dry
4A3 semi-convertible car.	19.0	97	3.2	Beach pebbles	Dry
4A3 semi-convertible car.	18.5	94	3.2	Beach pebbles	Dry
4A3 semi-convertible car.	21.0	89	4.4	1-in. crushed stone	Dry
4A3 semi-convertible car.	20.0	90	3.9	1-in. crushed stone	Dry
4A3 semi-convertible car.	21.5	112	3.5	1-in. crushed stone	Dry
2-car train....	24.5	177	3.3	1-in. crushed stone	Dry
3-car train....	24.0	200	3.1	1-in. crushed stone	Dry
4-car train....	23.0	215	3.0	1-in. crushed stone	Dry
4-car train....	22.0	173	4.1	1-in. crushed stone	Dry
4-car train....	26.0	232	3.7	1-in. crushed stone	Dry
4-car train....	24.0	193	4.0	1-in. crushed stone	Moist†
4-car train....	23.0	203	3.3	1-in. crushed stone	Moist†

* Rate of deceleration calculated as follows: One-half distance between center line of first wheel and last wheel on car or train subtracted from actual feet required to stop, this giving a length on which rate of deceleration was figured. The amounts subtracted in the various instances are as follows: For 20-ft. cars, 3 ft; semi-convertible cars, 15 ft.; elevated 2-car trains, 43 ft.; elevated 3-car trains, 64 ft.; elevated 4-car trains, 86 ft. † Mixed with sand and pebbles.

One surprising fact was the ease with which the trains were pulled back upon the running track. The accompanying table shows the test results in more detail.

The company has decided to install, on one side of the draw where eight-car elevated trains are operated, a track of this construction lying between the two existing



CROSS-SECTION OF BOSTON EXPERIMENTAL SAND TRACK

main-line tracks. This will cost about $40,000. Also gauntlet checking tracks will be built on both sides of the draw where two-car surface trains are operated; these will cost $5000 apiece. It will be necessary to cover the check ballast with tar paper or painted canvas to keep it dry and to prevent freezing in cold weather.

Hints for Use of Cold Mixtures for Bituminous-Pavement Patching*

The character of the mixture to use in patching bituminous concrete pavements depends entirely upon the conditions encountered. Unless the patching work is extensive, it is not advisable to use hot bituminous compounds in repair work, not only from an economic standpoint, but also from the point of convenience, for in small repairs the use of a mixing plant will materially increase the cost and entail unnecessary effort. Of course, where sections of considerable area are to be replaced, a mixing plant may become necessary.

Bituminous materials are being manufactured that can be mixed cold with the aggregates and tamped and rolled into place quite conveniently and inexpensively, and these have given good results. The different companies manu-

*From an article by George H. Biles, Second Deputy State Highway Commissioner, in the December issue of the "Pennsylvania Highway News."

facturing these materials have their own specifications for each particular product.

General practice seems to demonstrate that cold mixtures in the proportions of one part bituminous material to nine parts of ½-in. stone are quite satisfactory for all practical purposes. The material may be mixed on the road surface in a manner similar to the method used in mixing cement concrete, but care must be taken to remove the excess after the completion of the work.

In spreading bituminous concretes the tines of the rake should not be used in raking it into place, as this will cause a separation of the materials and the large aggregate will come to the top. The back of the rake will accomplish this work more satisfactorily.

Should depressions occur after the initial compression and rolling, the surface should be loosened up before additional material is applied to bring up the unevenness. Numerous cases may be found where repairs to roads of this type have not proved satisfactory. They are caused generally by the use of crude or improper methods or unsuitable material.

A patch should neither be above nor below the level of the surrounding surface to insure success and should be compacted as nearly as possible to approach the material in the road. Never place a bituminous patch on top of a bituminous surface to bring up a depression, unless the surface material has been heated and scored properly. It is always better to cut out the area and supply new material. A patch with a feather edge is but a temporary expedient and in a short time is sure to fail.

Fatty patches, which are caused by an excess amount of bituminous material in the mix, produce considerable unevenness in the surface of the road and are most unstable.

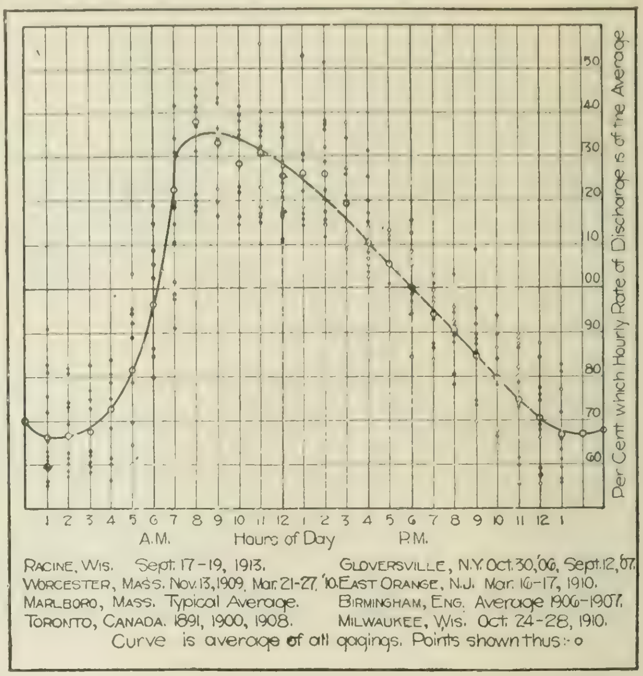
NOTES

A Record Drilling Performance in which a "Jackhamer" put down one hundred 4-ft. holes in 10 hours at the quarry of the Alabama Marble Co. is reported by the Ingersoll-Rand Co. This is drilling at the rate of 8 in. each minute of the day's work. The holes were nearly vertical and only a few inches apart. They were used for plug-and-feathers work. The drill worked at 100- to 110-lb. air pressure.

The Deep-Well Pumping Plants of Redlands, Calif., shown in the accompanying view, were constructed in 1913. The pumphouses are of reinforced concrete, and the towers are provided to cover the derricks used in pulling the pump rods. The wells being in sand and gravel formation, it seemed desirable to locate them some distance apart, which necessitated the construction of several buildings to cover the different pumps. These pumps are of the triplex deep-well type, having a capacity of 900 gal. per min. each. They have run constantly since their installation and have proved to be very efficient and economical in operation. The water lift is about 140 ft., and the depth of the wells varies from 250 to 700 ft. The total capacity of the plant is 7650 gal. per min. The deep-well triplex pumps operate at about the same efficiency as the single-acting triplex booster pumps, of which there are three in these buildings, to raise a portion of the water to the higher levels of the city. The foregoing information was furnished by George S. Hinckley, city engineer, Redlands, Calif.

DEEP-WELL PUMPING PLANTS—NOT CHURCHES

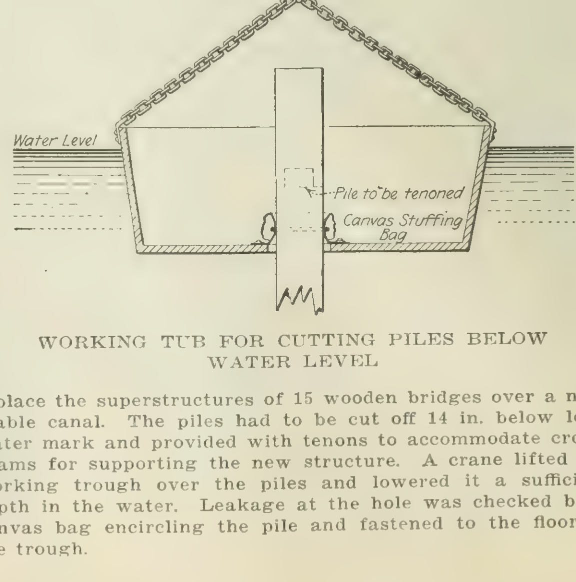
Hourly Sewage Flow Variation—The accompanying diagram is a composite of the hourly variation in sewage flow in six cities of the United States and in Toronto, Canada,



COMPOSITE CURVE FOR HOURLY SEWAGE FLOW IN VARIOUS CITIES

and Birmingham, England. It is reproduced from a recently published report on sewerage improvements at Davenport, Iowa, by John W. Alvord, consulting engineer, Chicago.

Cutting Piles under Water in very cold weather was done in Holland by using a large ballasted wooden trough or tub with a hole cut in the bottom for passing over the pile to be cut. Jan Spaander, 618 Forty-Fifth St., Brooklyn, N. Y., describes the application of this method to a special job, as shown in the sketch. A contractor was called upon to



WORKING TUB FOR CUTTING PILES BELOW WATER LEVEL

replace the superstructures of 15 wooden bridges over a navigable canal. The piles had to be cut off 14 in. below low-water mark and provided with tenons to accommodate crossbeams for supporting the new structure. A crane lifted the working trough over the piles and lowered it a sufficient depth in the water. Leakage at the hole was checked by a canvas bag encircling the pile and fastened to the floor of the trough.

Editorials

Why Not Two Concrete Mixers?

One very definite change in the 1916 report of the Joint Committee on Concrete and Reinforced Concrete was the recommendation that for normal mixers the batch should be kept in motion for at least 1½ min.—a 50% increase over the recommendation of the earlier report. This is in line with the best of current thought on concrete making and is the confessed ideal of many engineers. Unfortunately it is more than often an unattained ideal—unless it may be that concrete foremen's watches invariably run fast. The fact is that the average foreman more frequently aims to shave the mixer saleman's "batch-a-minute" than to follow the high-minded advice of the Joint Committee.

A solution of the difficulty too infrequently tried is the use of multiple mixers at one mixing plant, two or more drums all run by the same engine, all fed from the same bins and all delivering to the same chute, bucket or car. On very large works such as the Halifax harbor job or the McCall Ferry power plant such a battery of mixers is required by the large volume of concrete; but at times in such plants the mixers can be run simultaneously, feeding and dumping alternately, so that with three mixers running, each batch can be mixed 90 sec. and a batch dumped every 50 sec., leaving 20 sec. for loading and dumping operations at each mixer.

Why should not the same idea be applied to smaller jobs where one mixer dumping—under forced draft—every minute is the contractor's ideal? Here, for a very little greater first cost and hardly any addition to upkeep, two mixers could form a battery to work alternately, revolving the mixture long enough to suit the engineer and dumping fast enough to suit the foreman.

Sand or Mortar Bedding for Paving Bricks Still a Live Issue

The very much discussed point in brick and block-pavement construction, "Is a sand cushion really a *cushion?*" seems to have been answered in the affirmative by the United States Office of Public Roads and Rural Engineering, if the tests described elsewhere in this issue by Prevost Hubbard are accepted as meaning anything.

It has been the fashion lately to decry the term "sand cushion" as a misnomer and to theorize that closely confined and compacted sand under a pavement surface is as rigid as a layer of mortar. The tests made in Washington show that an impact hammer rebounded three times as far from a monolithic brick-pavement slab as from one that had a 1 or 2-in. sand cushion between the brick and the concrete base.

These tests confirmed the theory that a fracture of the brick wearing surface in the monolithic type of construction means fracture of the base also, thus getting away from the ideal pavement, which consists of a permanent foundation and a replaceable wearing surface. The most interesting feature of the tests in this respect was that brick bedded in a 6-in. concrete foundation to form a monolithic slab stood no greater impact than the brick laid on a sand cushion. It is significant, however, that the grout bond between the bricks failed under about half the impact required to fracture the brick, in the case of the sand cushion, and at nearly the same impact which fractured the brick in the case of the monolithic slab.

Interesting and conclusive as these tests are, so far as they go, the question is at once raised, What connection is there between laboratory hammer-impact tests and the experience of a pavement in actual service on the road? So long as a pavement is new and smooth, it is true that it will probably get little impact under any kind of traffic; but let there be a slight hump or depression, or a bit of hard stone, a bolt, bar or other obstruction on the surface, or an imperfect wheel, and there is bound to be impact or pounding under present-day high-speed motor-truck traffic.

The maximum breaking impact in the tests described was a 10-kg. hammer falling 95 cm., which is equivalent to 950 cm.-kg., or 825 in.-lb., which is the same as an 825-lb. weight falling 1 in. or a 1650-lb. weight ½ in.

The load on each of the rear wheels of the motor trucks that recently have destroyed granite-block pavements in New York City are approximately 12,000 lb., which means that one of them would have to drop but 0.07 in., or a trifle more than $\frac{1}{16}$ in., to have theoretically the same result as the impact hammer used in the tests, provided the full load came on one brick, as might happen due to slight inequalities of surface. The tires of these trucks are 8 in. wide; so if the load was distributed over the full width of two bricks, the drop necessary to cause a fracture of both bricks would be only ⅛ in.

It would seem from this brief computation that there exists a real relation between the impact tests made in the Washington laboratory and the experience of pavements on streets and roads.

New York's Garbage-Reduction Fuss

Again the expected has happened. After all the fussing, blowing and threatening over the location of garbage-reduction works for New York City on Staten Island, including 12 days of hearings and 1700 pages of typewritten testimony before representatives of the State Department of Health, under reference from Governor Whitman at the instance of Staten Islanders, the whole matter comes to nothing. First, George C. Whipple, the consulting sanitary expert engaged by the State Department of Health to sit through the hearings and report on the whole matter, declared that neither the transportation of the garbage in scows to Staten Island nor the treatment of the garbage there by the Cobwell reduction system would be a menace to health, although each might cause some local nuisance and other sites would have been preferable. These sites, however, were barred out when the contract was awarded. Next, Deputy Commissioner Williams and then Commissioner Biggs

after the concurrence of Chief Engineer Horton (all of the State Department of Health) indorsed the substance of Mr. Whipple's findings. This brought the matter back to roost with Governor Whitman, as stated on p. 125 of *Engineering News* of Jan. 18, 1917. Now comes Governor Whitman with a declaration that he has no jurisdiction over anticipated nuisances. Meanwhile the contractors have the work well on toward completion.

All this seems farcical enough. It appears still more so when it is noted that at the very outset of this tempest in a teapot, J. T. Fetherston, Commissioner of Street Cleaning, told the Staten Islanders what the law on the subject was and that they could choose between an action for nuisance after the plant was in operation and a big but futile demonstration meanwhile. A big hue and cry with no chance of a successful outcome on sanitary or legal grounds was the choice made, with the result to be expected.

This controversy required a large amount of time on the part of high officials in the State Department of Health, who might a hundred times better have been at work on real health-protective matters. It required much time on the part of others, as well as no inconsiderable cash outlay, that might have been far better used. But in some respects the worst feature of the whole proceedings was the spectacle of professional men who certainly ought to have known better solemnly testifying that an uptodate garbage-reduction works would be a menace to health. Such testimony hurts the professions of those who give it and by misleading the public delays public-health advance.

Wetting Down a Dry-Mixed Concrete

The problem of distributing concrete over a long-distance job—such work as the construction of a sewer, a pipe line or a subway—admits of numerous solutions. The plant designer can have small movable concreting plants delivering directly to the work and loading at frequent storage places, he can have frequent fixed plants with short-distance delivery by cableway, chute or derrick, or he can have one fixed concreting plant with long-distance delivery by train or truck.

The latter method itself has two variations: The concrete may be mixed normally and delivered wet to the forms, or it may be mixed and delivered dry and then wet down just before placing. Wet delivery has not proved very acceptable because of the segregation of the aggregate and the slopping over of the containers, so of late a number of contractors have tried the dry mix and delivery instead.

From the information received in the recent prize contest, in which Mr. La Brecque's paper on another page was awarded first prize, it seems that complete dry mix and delivery have their drawbacks and that some water has to be added at the central plant if labor costs at both mixer and forms are not to be prohibitive. The difficulties of the sloppy mix are then obviated, but there still remain the labor at the forms and the possibility of not thoroughly distributing the water to the cement particles.

Is there not a chance to improve the method by the use of one of the much despised trough continuous mixers or a baffled trough of gravity action? Such a mixer could readily be moved from place to place and be set up at the form, and the dry or semi-dry mix could run through it with a minimum of cost and time. In this way the advantages of central dry mixing could be retained; at the same time the preliminary mixing should be sufficient to permit a thorough mixing at the forms, for although the trough mixer is not efficient for total mixing, it might supply sufficient turning over to wet down aggregates already well mixed.

Europe's Needs After the War

There has been a very general belief in the United States that when the war terminates and the pressing demand from Europe for war supplies comes to an end, there will be such a slump in exports from the United States that business depression here will result. Those who have held this view have failed to realize that Europe after the war will be under the urgent necessity of restoring as promptly as possible its dislocated industries and must turn to the United States for a great part of the necessary materials and machinery.

A remarkable picture of the situation in Europe is drawn in the report of the American Industrial Commission, just made public. This commission of prominent American engineers and business men, which visited Europe a few months ago on behalf of the American Manufacturers Export Association, obtained from official sources a large amount of data as to the work of reconstruction.

The picture that the commission draws is of a vast extent of country over which the destructive wave of war has rolled and in which towns and cities must be rebuilt, roads and bridges must be restored, factories must have new machinery and new stocks of raw material. Even in the goods for immediate consumption, such as food products and materials for clothing, it will be many months before a sufficient amount can be carried to Europe to relieve the most urgent necessity; and it will be years before such a normal surplus of the necessaries of life can be accumulated there as existed before the war.

It is often forgotten that the effects of the war have not merely been felt in the hostile zone. Throughout Europe, all energies and expenditures have been of necessity turned aside from ordinary channels and directed toward the one supreme object of national defense. The cities of Great Britain, for example, have for nearly three years now been prohibited from borrowing money to make the usual extensions of water, gas and sewerage works, railways and lighting plants. Only the necessary maintenance work has been permitted. This is typical of what has gone on in the affairs of every corporation and every individual all over Europe. The work of repair, replacement and extension will have to be undertaken everywhere, whenever the stoppage of the war demands will permit.

What we are now face to face with and shall be for a long time is a condition of world-wide scarcity. It could not be otherwise. Fourteen of the chief nations of the world have for nearly three years been diverting to the task of destruction the energy formerly devoted to production. It is true that idlers have been set at work and that men and women by millions have labored with abnormal intensity, but that is far from offsetting the loss to productive work of the millions engaged in war and the supply of war's necessities.

A great deal has been printed concerning the marvelous efficiency in production that will result from the strenuous discipline of the war and the lessons it has taught in organization; but it will take time, and a great deal of time, to equip farmers and manufacturers and miners with sufficient food, raw materials and machines to enable them to operate again under normal conditions.

The Industrial Commission gives interesting figures as to the expenditure required for reconstruction in France alone. Over 750 towns in the war zone have been wholly or partly destroyed, and more than three times that number of towns, with four cities of over 100,000 population, are in the enemies' hands. In France and Belgium alone the immediate needs during the first year after the war will require for the rebuilding of destroyed factories and equipping them with machinery about $200,000,000 for buildings and $700,000,000 worth of machinery. The total destruction of public and private property in the war zone is estimated at about six billion dollars.

The Quality of Column Steel and the Strength of Columns

Another progress report has been rendered by the Steel Columns Committee of the American Society of Civil Engineers. Superficially viewed, this report seems to center about an old, long-known fact. Yet it presents new questions and suggestions in a degree sufficient to make it a most important document. It may, in fact, be called one of the engineering sensations of the season—at least so far as structural engineering is concerned.

The apparently central feature of the report is the "discovery" that the strength of a column depends on the yield-point of the steel. This is a very old discovery. The really important central point, on the other hand, is the committee's announcement of the fact that the quality of column steel is the main factor. This is bound to lead to new thought, to progress.

Early in its work, the committee focused its view on length-ratio and shape of cross-section, if a proper opinion can be drawn from its somewhat formal progress reports. Thereby it was led to undertake or share in a memorable piece of work—a series of experiments far superior in excellence to any prior wrought-column tests and indeed superior to all the prior tests joined together. It can hardly be said, however, that the analysis of length-ratio and shape of cross-section brought forth any notably new facts.

Reduction of strength with increased length-ratio was found, as was to be expected. Different normal column cross-sections showed up pretty nearly alike, as also was to be expected. But secondary factors came to view in the course of the work, and they have turned out to be the important ones.

There was, for instance, the mysterious phenomenon of columns made of thick metal turning out to be weaker than similar columns of thin metal. The materials were supposed to possess approximately equal strength, in specimen tests. But these specimen tests were made only in tension. Not until compression tests were made did the unsuspected fact develop that the materials were not alike, but were very different—different in compressive strength.

Thus, the committee demonstrated a year ago that column material may not be judged in tension. It has strengthened the demonstration during the past year by making a number of compression tests. The bridge builder who buys column steel on the basis of tension tests is in danger of going astray as far as the committee did, when it bought different lots of material and believed them to be of equal strength merely because they gave equal tensile specimen tests. The bridge builder ought to make compression tests, if he wishes to know what he is getting. The fatal difficulty, however, is that compression tests are hard to make, and no one wants to make them—neither the steel mill nor the bridge engineer.

The committee may provide a convenient solution of this difficulty by devising methods and formulas for computing the compressive strength from the (measured) tensile strength. Of course, it may fail in this endeavor; but to make a start with the problem, it is about to study the question, "What is yield-point?"

This question has in the past engaged many minds and has produced numerous papers and discussions. Well may we look forward with interest to whatever new light the column committee can project on it. For the present it is only necessary to remember that many engineers believe in the *a priori* identity of tensile and compressive yield-point, provided both are measured in the right way; if that belief be correct, it would only be necessary to find a way of measuring tensile yield-point so that it will be equal to the compressive yield-point.

Very directly related to the yield-point question is another which the committee is investigating—namely, the effect of eccentric loading, or, stating it in other terms, the effect of moment and direct load combined. Such combined loading necessarily stresses one side of the column more than the other; and if the load be increased sufficiently, one side will reach the yield-point stress before the other. Now, it is possible to attain this yield-point stress on the one side in different ways—by less load and more moment, or by more moment and less load. Will failure take place for the same extreme-fiber stress under these two load arrangements? In all our structural analyses we assume that it will. Yet, strange to say, no experimental evidence on this question is on record. The committee will provide it, we may hope.

These inter-related questions of yield-point and eccentric load represent a very long and highly involved problem. A definite answer can hardly be expected within the year. But, in compensation, the committee promises to report on the influence of details, or in other words on how to design column ends and connections so as to realize the full strength of the shaft.

The principles of perfect column design have not yet been written down in the records of the structural engineer's art. It is not hard to make a perfect column without ends, if we may use such a term; by applying the load to the shaft metal direct, the full strength of the shaft can be developed. What we need to know is how to apply jaw plates and gussets and battens and pin-plates, transfer the full column load through them and still have 100% of the shaft strength available. Some very recent tests, which point to the harmful influence of even a very few rivet holes in a large member, afford a fresh reminder of the difficulties in this field of detailing. The committee will make a lasting name for itself when it writes a comprehensive treatise on 100% detailing of columns.

Letters to the Editor

Wanted: Results of Private Research

Sir—The undersigned committee on Engineering of the General Committee on Research of the American Association for the Advancement of Science feel that it is timely to issue the following appeal to industrial research laboratories.

In the course of work done in the numerous industrial laboratories of America, many physical and commercial constants and data of great scientific interest and value are doubtless arrived at, and which may, for a certain period of time, constitute an asset of considerable commercial value to the particular corporations in question. During this period, everyone recognizes the proprietary right of the industrial laboratories to the retention of this information.

A time frequently arrives, however, when such scientific information loses its commercial value (often by being duplicated in other laboratories), and just at this point we wish to impress upon the industries their obligation to enrich scientific literature with such facts and data, which might otherwise be lost or forgotten.

Some of our industries have been reproached with the suspicion of acting as sponges, in that they absorb an immense amount of useful information from scientific literature without giving any return in kind. This suspicion would be entirely removed if, from time to time, scientific information which has ceased to be of commercial value were contributed by them to its appropriate channel and thus became available to all scientific workers throughout the world.

If any doubt exists as to the appropriate channel for the publication of such scientific data and communications, the secretary of the American Association for the Advancement of Science, Dr. J. McKeen Cattell, Garrison-on-Hudson, New York, will be glad to act as intermediary and to forward such communications to the proper scientific body.

A. E. KENNELLY, J. W. RICHARDS, A. SAUVEUR,
A. N. TALBOT, C. C. THOMAS.

Cambridge, Mass., Jan. 27, 1917.

How To Bind Your "News" Copies

Sir—I notice in the issue of the "Engineering News" for Jan. 11, under the head of "Really Good New Year's Resolutions," that Mr. "Make a Few Resolutions" has made some excellent ones; and while fully agreeing with him that the fewer resolutions made the more apt they are to be kept, I fully believe just one more should be added. It is this: In addition to reading the "News" we should all preserve our copies and bind them for future reference.

Here are a few simple directions for those who would like to bind their copies, but imagine it is a lot of work:

1. Take the papers to a good bench or table and open up the front to the first page of reading matter; hold firmly down to the table and tear off the front advertisement pages.

2. Open up the back and with an awl or other instrument loosen the clinches on the wire staples.

3. Divide the paper at the division between the reading matter and the "Construction News" section and cut through the back at the ends with a knife, to start the division at the proper place; then holding tight as before, pull the back portion loose from the staples.

4. Turn to the front and remove the bits of paper still remaining under the staples; then turn to the back, bend down the staples and clinch with a light hammer.

5. Lay the back to the edge of the table, and with the corner of a triangular file the rough edges of the paper may be easily removed, as well as the glue, leaving the back in good shape for binding

6. Mark two points 2¼ and 9¾ in. from the top and ¼ in. from the edge and punch with a small size harness punch for the wires in the regular binders furnished by the "News." This marking is easily done if one has a carpenter's square available, for the paper can be laid so the top of the papers will be alike and throw all irregularities in the cutting to the bottom.

7. Place in the binder with the index and file for future reference in your bookcase. WILLIAM R. KINDER.

Troy, Ohio, Jan. 15, 1917.

Percolation Tests of Sewer Pipe

Sir—Permit me through your columns to ask the sentiment among city engineers as to whether or not sewer pipe should be submitted to a percolation test; and if it should, then how severe a test. The general opinion with regard to clay sewer pipe has been that the pipe is impervious. However, a few city specifications have included a percolation test, notably the specifications of Kansas City, as published in "Engineering News" of Apr. 30, 1914.

Recently the City of Tucson, Ariz., included a percolation test in its specifications for a large sewer contract, and the pipe that has been furnished does not fulfill the specification, which calls for a 5-min. test at 15 lb. per sq.in. without sweating. Much of the pipe, indeed, sweats with 5 lb. pressure. As a result the contract was held up for a considerable time, and the Engineering Department was subjected to very severe criticism.

I wrote to the city engineer of Kansas City to inquire the duration of the test for his 10-lb. percolation specification and was suprised to learn from his reply that that particular clause is not used—that is, that no percolation tests are being made. Of course I wrote him again, asking why the clause was included in the specifications if it was not to be used.

The criticism in Tucson was due largely to the fact that the percolation clause was not being enforced, and it was felt by citizens that the clause may have increased the cost of the pipe without accomplishing any good. At that time much of the pipe was already in the ground. The writer, with two other engineers, after examining the pipe and finding that it withstands from 35 to 60 lb. internal pressure and is thoroughly burned, reported to the City Council that it is good pipe and satisfactory for the purpose intended.

Sewer pipe is not subjected ordinarily to more than 1 or 2 lb. pressure, and it is the common belief of engineers, I think, that sewer pipe, either clay or cement, soon becomes sealed tightly and covered with a slime that makes the friction factor quite independent of the material. A slight percolation when the pipe is new might result in a damp soil surrounding the pipe, but oxidation would prevent any objectionable result. Only in case the pipe is laid below or near the ground-water table and in the vicinity of domestic supplies would there be danger of injury.

The engineer of sewers of Kansas City has just submitted a statement of percolation tests made in the past, mostly in 1914. These tests are certainly of great value, well worth publishing in full. Most of the pipe tested were of concrete and ranged in size from 8 in. to 21 in. In general, the pipe withstood 10 lb. and even 15 lb. pressure indefinitely without sweating, and in many cases there was no percolation up to 30 lb., in one case up to 78 lb. Three tests of clay pipe were included. A 15-in. clay pipe showed seepage with 15 lb. pressure after 40 min. and an 8-in. pipe after 50 min., while a 10-in. clay pipe withstood 10 lb. for an hour without signs of seepage, with only two small moist places during the next hour when under 15 lb. pressure, so the engineer was quite justified in assuming that sewer pipe is practically impervious and that testing for percolation is unnecessary. Some tests that have just been made seem to confirm the assumption.

However, pipe made in various parts of the country may be quite variable in character. Undoubtedly the quality of the clay, as well as the method of manufacture, affects the perviousness of the pipe. So it is desirable to know what, if any, should be the minimum requirement to be used in specifications, and many city engineers, I feel sure, will welcome a discussion of the subject. G. E. P. SMITH.

University of Arizona, Tucson, Dec. 26, 1916.

A Subaqueous Rock-Breaking Machine in use on a number of Government contracts was described in "Engineering News" of Feb. 4, 1909, p. 125, by Burton H. Coffey, M. E. Information is desired as to the present location of Mr. Coffey or of the Submarine Co., which was stated to be the owner of the patents on the apparatus.

Conservancy Case Defeated at Columbus; City To Enlarge River Channel

Defeat of the Franklin County Conservancy District flood-protection project on Jan. 9 ended the hearing before the Conservancy Court, formed of the Franklin County judges, which began Dec. 6. In a preliminary decision the court decided against the proposal to enlarge the district to include the whole area affected by the protection. Then the court ordered testimony presented on the financial practicability of the conservancy plan under the proviso that the whole cost of the plan should be assessed against Franklin County; consideration of the technical features was left for possible subsequent proceedings. On this financial question the court decided Jan. 9 that the cost of the plan is not justified by the benefits:

> Upon a consideration of all the evidence, and giving due consideration to the contention of each side as to the ability of the property in the flood zone to bear the assessments necessary to carry out this proposed plan of improvement, we are unanimously of the opinion that the assessment will be much beyond the benefits likely to be derived from the carrying out of the plan.
>
> We have . . . assumed for the purpose of this hearing, that the plans are efficient and adequate, and will afford the protection claimed for them by the engineers who prepared them. We are only deciding the question of the feasibility of this plan from a financial standpoint.

The decision of the court, though long, gives no clue to why the court reached its decision, nor does it give any measuring stick by which an opinion might be formed as to what expenditure would be confiscatory and what would not be.

Further action on the part of the Conservancy District (which was not dissolved) is in abeyance pending action by the city, which has a channel improvement project of its own. The district has been considering a modified plan, one giving less protection than that passed on by the court but sufficient to just about accommodate the 1913 flood.

The modified plan includes the Dublin retarding basin of the prior project and sufficient channel improvement through Columbus to take the discharge from this basin. It is possible to secure complete protection against a recurrence of the 1913 flood by this modified and cheaper project. The cost to Columbus and Franklin County will be fully as much as under the prior plan if distributed over the whole benefited territory from Delaware to Chillicothe, although the latter plan will take care with safety of a flood 45% greater than the 1913 flood. The modified plan will be much less burdensome to the west side of Columbus, which is the district on which flood benefits must be particularly assessed; the difference will be particularly large if the city undertakes some of the work by general taxation.

Channel Improvement by the City

As the outcome of a proposal made late last fall by a citizen of Columbus that the city enlarge the Scioto River channel through the city to 580 ft. wide, on the claim that this would give complete flood protection, the city has just approved such a plan. City Engineer Henry Maetzel, who investigated the proposal at the direction of the council, reported months ago that the proposed enlargement would carry only a small part of the flow claimed for it, and that it would cost at least 50% more than the $3,500,000 which was stated to be its cost by its promoters. Following a popular vote at the November election in favor of a $3,500,000 bond issue for channel widening, the council ordered the city engineer to prepare plans for a $3,500,000 channel improvement and for a 580-ft. channel improvement.

The report on this planning was rendered Jan. 15, 1917. It outlines the nature of the 580-ft. channel widening, which would extend approximately from Fifth Ave. on the Olentangy River, down the Olentangy and the joined Scioto to the municipal railroad bridge below Greenlawn Ave. No change of the bed of the stream is contemplated. The cost is estimated at $4,500,000 and the flow capacity as 100,000 sec.-ft. safe (6 ft. below levee top) and 130,000 sec.-ft. at the calamity point. The city engineer recommends that in view of the 140,000 sec.-ft. flow of the 1913 flood, spillways in the levees be provided at proper points to permit water in excess of the channel capacity to pass over the top and submerge the low lands without washing out the levees, by this means providing for an additional flow of about 10%.

The $3,500,000 plan would include widening and improving the existing channel of the Scioto from the confluence south to Greenlawn Ave. The channel would have a flow capacity of 80,000 sec.-ft. safe and 105,000 sec.-ft. at the calamity point. Here also spillways for the levees should be provided at suitable points. The capacities were figured with a roughness coefficient 0.035 in Kutter's formula.

In a verbal report to council the city engineer recommended building a channel somewhat smaller than that reported on in his formal report, and in connection therewith a detaining reservoir at Dublin, on the upper Scioto, one of the two locations selected by the Franklin County Conservancy District for a dam. This dam would also furnish an auxiliary water-supply to Columbus, which soon will be short of water. The verbal recommendation was disregarded, and a week later the council adopted a resolution instructing the city engineer to go ahead with the $3,500,000 channel improvement. The first step in the work is to be the preparation of complete plans and specifications and a report on what organization and equipment is necessary for such work, together with a description of all lands that require to be taken. Mayor George J. Karb approved this resolution Jan. 23.

A peculiar feature of the situation is that under the conservancy law the still existing conservancy district has sole jurisdiction over the planning and construction of flood protection works and the like. There is a possibility, therefore, that the city's action lacks authority.

The New Rapid-Transit System of New York City, according to an announcement made by the Public Service Commission will have important portions of the system put into operation in 1917. Only six general construction contracts out of 90 remain to be let. The total amount of work on the new lines completed, under construction and under contract on Dec. 31 aggregates $196,279,000. In addition, about $15,000,000 has been spent for real estate, and the two corporations that are to operate the line have expended or let contracts for about $35,000,000 worth of work in connection with the lines which they own, besides about $20,000,000 for equipment. The lines that it is hoped to put into operation during the coming year are the Lexington Ave. line, with its Jerome Ave. extension, and a part of the Southern Boulevard extensions; the Seventh Ave. line, and possibly part of the Flatbush Ave. and Eastern Parkway subway in Brooklyn, all to be operated by the Interborough company. It is also hoped to have part and possibly all of the Broadway subway in Manhattan, to be operated by the New York Consolidated Railroad Co., in service before the end of the year.

Sanitary and Storm Sewers Combined in One Structure, Flint, Mich.

By R. E. Spear*

A design for proposed sanitary and storm trunk sewers at Flint, Mich., is shown herewith. The two sewers will be combined in one structure (Fig. 1) except where it

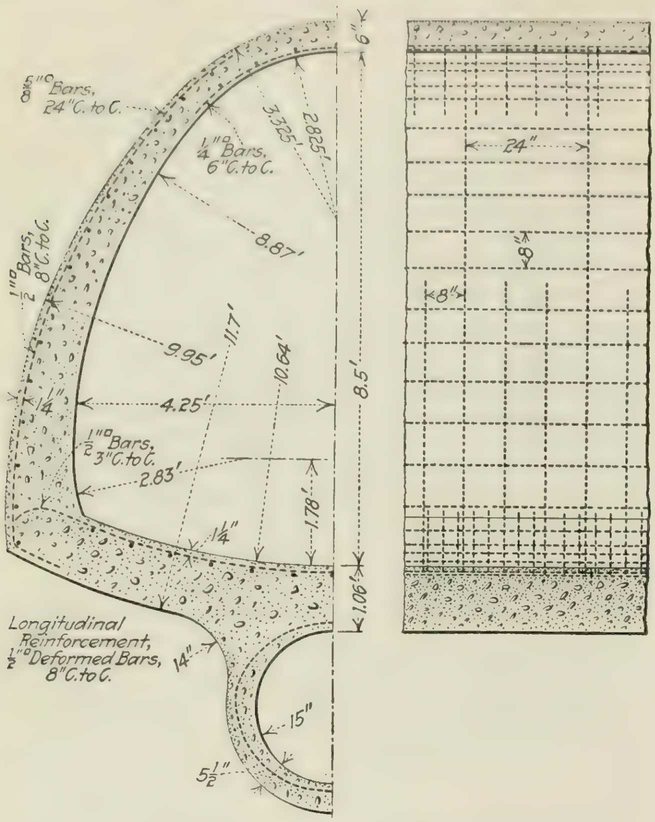
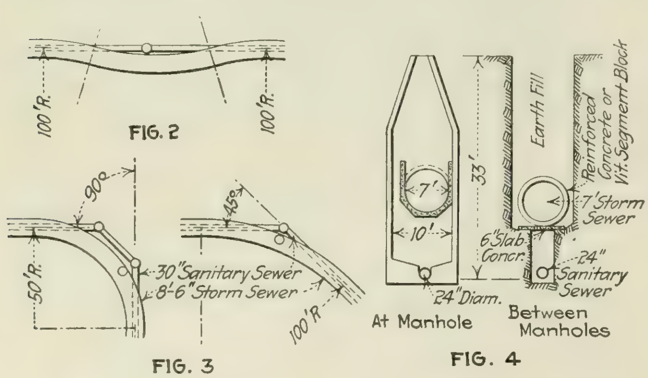


FIG. 1. CROSS-SECTION OF STORM AND SANITARY SEWERS, FLINT, MICH.

is necessary to have a manhole on the sanitary portion. At such intervals the following methods are used:

On a tangent a double reverse curve of 100-ft. radius is made in the storm-sewer portion only, thus separating



FIGS. 2 TO 4. DETAILS OF STORM AND SANITARY SEWERS, FLINT, MICH.

in plan the two sewers a sufficient distance to permit the building of a manhole over the sanitary sewer (Fig. 2).

At all angles in the alignment of the sewer a simple curve of 50-ft. radius is made in the storm-sewer portion only. The sanitary sewer is carried a sufficient distance beyond the P.C. and P.T. of the storm sewer to permit the building of two manholes on the sanitary sewer in case the deflection angle of the sewer line is between 15 and 90°, and one manhole in case the deflection angle is 15° or less (Fig. 3).

Fig. 4 illustrates the type of construction proposed for that portion of the trunk line in which it becomes necessary to separate in profile the two sewers. The maximum depth of sewer is 33 ft., and the minimum depth is 15 ft.; the approximate cost is $400,000.

At the time this sewer was designed Ezra C. Shoecraft was city engineer, and W. R. Drury was assistant engineer. The writer was ably assisted by H. E. Miller, University of Michigan, 1916.

*Engineer on sewer design, Flint, Mich.

Impact Test of the Efficacy of Sand Cushions in Brick Pavements*

By Prevost Hubbard†

Many conflicting opinions have been expressed by various engineers as to the relative merits of the monolithic and sand cushion types of brick pavements as well as cement grout and bituminous joint fillers for brick. While these opinions have undoubtedly been based upon personal observation or experience, very little definite data have been presented upon the subject other than that included in certain generalities.

It was felt that information of some value might be obtained by conducting certain physical tests upon sections of brick pavements constructed in the laboratory. Upon the suggestion of C. H. Moorefield, a series of laboratory tests was therefore started a few months ago in the United States Office of Public Roads and Rural Engineering. To date these tests, which should only be considered as preliminary, have developed a few facts which appear to be of sufficient interest to warrant presentation.

Because it could most readily be made, and also because it gave promise of developing facts of most interest, an impact test was decided upon for preliminary investigations. The large Page impact machine of the office was made available for testing sufficiently large sections of pavement by inserting a flanged section under the main supporting column so that the plunger could be raised high enough to place beneath it a test specimen ten or more inches in thickness.

The sections of pavement for test were constructed in a rectangular bottomless box mold or frame made of 3/8-in. boiler plate. This frame was sufficiently deep to allow for a 6-in. concrete foundation and 1-in. cushion in addition to the paving brick. Allowing for joints, the area of the test section was that of six bricks arranged in three rows with two whole bricks on the outside rows and a whole brick in the center, flanked by two half bricks.

For all tests here reported a 1 : 3 : 6 concrete base was cast in the frame and allowed to age for at least 7 days before testing. Upon the base the brick were set in some cases upon a 1-in. or 2-in. compacted sand cushion, and in other cases upon a 1 : 3 cement mortar cushion

*Discussion at the road meeting of the American Society of Civil Engineers, Jan. 17, 1917.

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spread dry upon the green concrete. Some sections were grouted with a heated bituminous filler.

Tests were made by placing the entire specimen in the frame upon the anvil of the impact machine, so that the plunger rested upon the center of the upper surface of the center brick. The blow of a 10-kg. hammer was then delivered in increasing increments of 5 cm. drop. The rebound of the hammer was measured for each blow and the height of that blow which caused failure was noted, together with any particular conditions of interest which developed in the specimen during test.

In these tests two lots of paving brick, repressed, and wire cut lug, were obtained from a brick manufacturer with a request that at the plant each lot be selected with a view to including as uniform brick as possible. When subjected to the rattler test, however, there was found to be considerable variation in the loss of individual brick although the average was low, as shown in Table 1.

TABLE 1. TESTS OF REPRESSED AND WIRE-CUT-LUG PAVING BRICK

Rattler Test:	Repressed	Wire Cut Lug
Minimum per cent. loss	14.2	13.7
Maximum per cent. loss	20.2	24.2
Average per cent. loss	17.2	17.8
Toughness Test (10 Kg. Hammer):		
Minimum blow, centimeters	46	40
Maximum blow, centimeters	60	50
Average	51	45

From this table it is also evident that considerable variation exists in the resistance to impact offered by individual brick, the toughness values given being the results obtained by testing eight individual brick of each type. The cement and aggregate used in the preparation of the concrete, mortar cushion and grout met the usual test requirements.

The results of tests upon sections of pavement constructed with the repressed brick are shown in Table 2.

TABLE 2. TESTS OF PAVEMENT SECTIONS OF REPRESSED BRICK

Filler	Cement Grout						Bituminous
Cushion	1-In Mortar			2-In. Sand		1-In. Sand	1-In. Sand
Age of Grout	7 Da.	14 Da.	28 Da.	7 Da.	28 Da.	28 Da.	2 Da.
Maximum blow, cm	80	90	95	80	95	80	90
Grout cracked at cm	70	..	80	40	40	40	No
Maximum rebound, cm	23	26	25	7	10	8	5
Base cracked	Yes	Yes	Yes	No	No	No	No
Brick left base	Yes	Yes	Yes	.	..	.	..

Check tests were made in a number of cases and found to run close together. Where such checks were made the average results are given in the table.

Upon comparing these results it will be seen that the following facts are indicated, if not conclusively proved:

1. As compared with a sand cushion the monolithic type of construction does not protect the brick from the effect of impact but does tend to increase the resistance to impact of the grout filler when the blow is delivered on the brick. In the monolithic structure there is therefore less tendency for the grout filler to separate from the brick, although failure of the grout may be expected to occur before a general failure of the brick.

2. In the monolithic structure failure of the brick under impact resulted in failure of the entire structure, including the foundation, while with a sand cushion no failure in the foundation occurred under the impact which caused failure of the brick. This fact seems to throw into question the recommendation frequently made of employing a thinner foundation for the so-called monolithic type of construction.

3. The capacity of the monolithic pavement for absorbing the shocks of impact is less than where a sand cushion is used.

4. There seems to be no great difference in effect between a 1-in. and a 2-in. sand cushion. When the grout failed, however, there appeared to be a greater vertical displacement of the center brick on the 2-in. cushion than on the 1-in. cushion.

5. The bituminous filler protects the brick from the effect of impact fully as much as the cement-grout filler and does not itself fail even when the brick fails under impact. It should be noted that no apparent vertical displacement of the brick occurred where the bituminous filler was used.

6. As compared with cement grout the bituminous filler apparently increases the capacity of the sand cushion pavement for absorbing the shock of impact.

7. In comparison with the results of impact tests upon individual brick it is of interest to note that in the pavement this resistance is almost doubled, irrespective of the type of filler.

A few tests have been made upon wire-cut-lug block sections of pavement with results quite similar to those given above. It is proposed to continue this investigation with various makes of brick and to use other types of filler and cushion such as bituminous grout or mortar.

Belgian Relief Work Organized by an American Engineer

Every member of the engineering profession in the United States ought to be proud that the great work of saving the people of Belgium from starvation was organized and has been carried out under the direction of an American engineer. The story is not new, of course, but probably few engineers realize the magnitude of the task that has been accomplished by the organization headed by a member of their profession.

In the *Engineering and Mining Journal* of Jan. 20, W. L. Honnold, who is in charge of the American office of the Belgian Relief Commission, describes how, after the conquest of Belgium by Germany in the fall of 1914, its people were face to face with famine. Belgium is the most densely populated country in Europe and produces within its own borders less than one-third of the food it consumes. Imports were stopped, commerce was paralyzed, and under the sudden wrench of military occupation the Belgian people were unable to do anything for themselves. A few resident Americans and leading citizens organized an emergency committee. The support of the American and Spanish ministers to Belgium was enlisted. Assurances were obtained from the British and German Governments that a commission organized under neutral control might import and distribute food to the Belgian people.

The American ambassador to Great Britain, Walter H. Page, was asked to nominate a man to head the commission and named Herbert C. Hoover. Mr. Hoover is a native of Iowa, who graduated in mining engineering from the University of California in 1895 and has by his own ability as an engineer and executive attained a leading position in connection with mining enterprises in China, Australia and other countries. He has long been recognized in Great Britain as one of the leading mining engineers of the world.

An American relief committee, in which Mr. Hoover was prominent, had been organized at the outbreak of the war to aid in the work of sending home the thousands

of American citizens stranded in Europe at that time. With this reorganized committee as a nucleus, Mr. Hoover set about the gigantic work of providing food for starving Belgium. The first money obtained was raised by private subscriptions. It soon became evident that the task was so huge as to exceed any possibilities of financing by private contributions alone. Mr. Hoover went personally to the Government officials of Great Britain and France and secured from each of these countries a monthly contribution of $2,500,000 for the work of the commission. From certain French institutions $1,000,000 per month was later received, and this enabled the commission to help those requiring relief in the war-swept portions of France. With these sums have been combined the private contributions obtained from all parts of the world, but still the amount has been insufficient to meet the need. As a result of a further appeal to the Governments concerned, England last year doubled her monthly contribution and France has added 40% to its subscription for the relief of the inhabitants of northern France. These increases, however, still leave the commission short some $3,000,000 per month of the sum required to provide the people of Belgium with what is considered a minimum living ration. How serious the condition is may be judged by stating that even if this extra $3,000,000 were available, the rations to the destitute Belgians would be less by one-fifth than that given by the Germans to their prisoners of war.

Some idea of the magnitude of the work which the Relief Commission has carried out may be given by figures. On Oct. 31 last, the commission had imported into Belgium 2,190,000 tons of food, at a cost of $173,-658,000, while over $28,000,000 was in transit. This food had been brought by 356 transatlantic ships and 763 cross-channel ships and had been transported into the interior of Belgium by 5913 canal lighters.

The task of purchasing, transporting and distributing this vast amount of material, supplying the necessities of life for over 7,000,000 people in Belgium and 2,250,000 people in northern France, requires a large organization, and it has to carry on its work with careful regard to the restrictions imposed by the various Governments involved.

Through the efforts of Mr. Hoover and his associates, coöperation, financial assistance and reduction in rates have been secured from a large proportion of those who are carrying on the commission's work. Most of the department heads of the commission and many of the assistants also are volunteers who give their services either gratis or for only their living expenses. The efficiency with which this vast work has been carried on is indicated by the statement that the overhead expense of handling this enormous business, including that incurred by all the Commissions' offices in Belgium and in foreign countries, has averaged only 5/8 of 1%.

Those who threw themselves heart and soul into this enormous task when the emergency came, nearly three years ago, had no idea, of course, at that time of its long duration. Some months ago the commission proposed to relinquish the work and turn over the task to the people of Belgium. The Governments concerned, however, declared that in order that the work should continue it must remain in neutral hands. In an address last May by the British prime minister, Mr. Asquith, he referred to Mr. Hoover's work as a miracle of scientific organization and continued:

Mr. Hoover and those associated with him have had to provide and are providing every day food for over 9,000,000 persons. I desire to express on behalf of the Government our deep gratitude to Mr. Hoover and to those American citizens who have so nobly given up their time and their occupations, without recompense and to a large extent without recognition, to this work of purchasing, shipping and distributing the supplies which alone enable the population of Belgium to keep body and soul together. It is one of the finest achievements in the history of humane and philanthropic organization.

Mr. Hoover, who arrived in New York on Jan. 20, is appealing to the American people for additional contributions, to the amount of $1,000,000 per month, so that a little more food may be given to the school children of Belgium. The commission has had thorough investigations made by Dr. William C. Lucas, of the University of California. He reports that the effects of the scanty food allowance on the Belgian people are chiefly evident in an alarming reduction of vitality and increase in tuberculosis and similar diseases among the children of school age. The commission estimates that to counteract this undermining of the health of the coming generation it must spend about $1 per month for each child, or $1,000,000 per month for the 1,000,000 children who need extra sustenance. To aid in raising the funds required for this work, American engineers and others willing to contribute are asked to subscribe to the stock of "Belgium Kiddies, Ltd." The stock is issued at $12 a share, and every purchaser of the stock is sure of a dividend return in the consciousness that for every share of stock that he buys an under-nourished Belgian child will receive one badly needed meal a day for a whole year. Contributions may be sent to the Belgian Relief Commission, 120 Broadway, New York City.

There is a prevalent impression that the United States has been a liberal contributor to the relief of Belgium. The fact is that the total contributions from the United States amount to only 8c. per capita of her population. In contrast to this, Canada has contributed 18c.; Australia, $1.23; New Zealand, $1.98; and Tasmania, $6.53 per capita for Belgium relief. These countries which have contributed with such generosity compared with the United States are countries whose people are suffering all the losses and extra demands which come as a consequence of being engaged in the war. The United States, on the other hand, of all countries in the world has had a prosperity as a result of the war such as was never known. Moreover, nearly all of the $200,000,000 which the commission has expended in buying food has been spent in the United States.

This is a great work for humanity, organized and carried on by American engineers who are themselves devoting their time and ability without thought of recompense.

Mr. Hoover and his associates have done more in the past two years to bring honor and credit to the United States among the peoples of Europe than any other Americans. They surely deserve and ought to receive in their great work the financial support of their countrymen.

Water-Supply Difficulties—Fort Scott, Kan., has been short of water since August, 1916. To help out the supply it has dug ditches connecting pools over a course of 30 mi. in the Marmaton River. The authorities expect to construct additional dams in the river to impound water. As far back as 1913 the people voted $32,000 for a filter plant, but at the same election the officials who had favored the plant were defeated for reëlection, and as a consequence the appropriation has never been expended.

News of the Engineering World

Mount Royal Tunnel Nearly Finished

It was recently reported in Montreal that the Mount Royal tunnel of the Canadian Northern Ry., under the City of Montreal, is very near completion and that the permanent tracks are now being laid. Work had been practically stopped for a year because of the war. It is expected that, in June, the regular trains of the railroad will be running through to a temporary city station that is to cost about $150,000. Two of the six locomotives first ordered have been delivered by the General Electric Co. and will be used on construction. The substation equipment has been installed.

St. Louis Municipal Bridge Opened

The completion and opening of the highway deck of the St. Louis Municipal Bridge across the Mississippi River, was the occasion for a general municipal celebration in St. Louis on Jan. 20.

A huge chain was stretched across the roadway at each end of the bridge and each of the chains was fastened by a unique padlock made in the blacksmith shops of the city organization engaged in the bridge construction.

The President of the Board of Public Service presented the key to the Mayor of St. Louis, who opened the lock and admitted the crowd to the bridge. The Mayor afterward took the lock to the center of the bridge and threw it over into the Mississippi River, thus symbolizing the removal of all impediments to free access from St. Louis to East St. Louis.

The bridge is double decked, the lower deck being for steam-railway traffic, the upper one for foot, automobile, wagon and electric-railway traffic. The bridge with highway approaches is 9797 ft. long, and with its railway approaches 18,258 ft. The channel span is 2022 ft. From the highway deck to the low water mark the distance is 143 ft.; from the railway deck 115 ft. The clearance is 65 ft.

New Governor's Recommendations for New Jersey Highway Reform

The new governor of New Jersey, Walter E. Edge, who was inaugurated Jan. 16, has propounded some different theories than those recommended by the special commission appointed by former Governor Fielder, an abstract of whose report was published in *Engineering News* of last week. In his inaugural address Governor Edge states that he "believes in a thorough reorganization of the road department, including the establishment of a modern highway system." He said that the $7,000,000 provided for in the recent bond election would not under any conditions be sufficient to build the highways specified and that the act was impracticable, if not absolutely impossible.

The new governor recommends that funds for new state highways be provided by a temporary state tax on all ratables. He would reorganize the highway department by creating an unpaid highway commission of eight members, three of whom would be engineers, which would have the power of appointing a state highway commissioner or highway engineer. He advocated liberal state aid for the improvement of township earth roads and the universal adoption of the patrol system of road maintenance, even to the extent of refusing state aid for any county improvement where the patrol system of maintenance was not provided.

San Francisco Loses Incinerator Suit

The suit of the Destructor Co., of New York City, to recover $160,000 from the City of San Francisco for the construction of the Islais Creek incinerator and a portion of the equipment of the North Beach incinerator was decided Jan. 18 in favor of the Destructor Co. in the Federal District Court. According to City Engineer M. M. O'Shaughnessy, an immediate appeal will be taken from the decision and the case will be carried, if necessary, to the highest tribunal.

The contract for two incinerators of 120 tons capacity at a total of $255,000 each was awarded on Nov. 28, 1910, under specifications drawn with Rudolph Hering, New York City, as consulting engineer, and Marsden Manson as city engineer. Soon after Mr. O'Shaughnessy became city engineer he examined incinerators in the East and concluded that the Destructor Co. would not be able to comply with its contract on account of the heavy moisture content of the San Francisco refuse—50%. He ordered construction on the North Beach incinerator discontinued until the Islais Creek plant had been completed and tested. On the basis of tests made late in 1914, Mr. O'Shaughnessy advised the rejection of the plant on the grounds that it did not comply with the specifications, inasmuch as a nuisance was created in its operation and that obnoxious odors, smoke and dust escaped from the building or the chimney. The company brought suit, as stated above. (See *Engineering News,* Nov. 26, 1914, p. 1096 and Dec. 10, 1914, p. 1190.)

River des Peres Preliminary Plan Approved at St. Louis

The Board of Public Service of St. Louis has adopted a preliminary report and plan for the improvement of the River des Peres in that city, prepared by the Division of Engineering Design under the direction of W. W. Horner, Chief Engineer. Money for the improvement has not yet been provided.

The River des Peres is an open stream running through the City of St. Louis for about 18 mi. It has a drainage area of about 70,000 acres, three-fourths of which is outside the city.

The city has constructed many sewers discharging into this stream and the stream itself is now a serious nuisance in dry weather and its floods, which have become more

serious each year, have caused an enormous amount of damage.

The preliminary plans provide for completely inclosing the stream in reinforced-concrete sewers for about 4 mi. and for constructing a large open channel with sloping banks and lined with reinforced concrete for a distance of about 9 mi. This plan decreases the length of the stream approximately 5½ mi. The largest sized reinforced-concrete sewer proposed will consist of twin arches each 29 ft. wide and about 21 ft. high. The estimated cost of the project is $6,700,000 in addition to approximately $1,000,000, which has already been spent on partially completing a sanitary intercepting sewer along the route of that portion of the improvement on which the storm water will be carried in an open channel.

The outlet of the drainage scheme is into the Mississippi River and the report contains the interesting study of the probabilities of the stages in the Mississippi River against which the channel will discharge as compared to the probable occurrence of intense precipitation.

Another interesting feature is the high rate of runoff provided in the design. This rate varies from 0.72 cu.ft. per sec. per acre at the outlet to as high as 1.10 cu.ft. per sec. per acre at a point about 12 mi. from the outlet. In determining the rates of runoff, the report contains a prediction of the rate and growth of population in the now rural areas and sets values on the rates of runoffs from such areas by districts.

The whole design is based on the rational method of determining runoff as now commonly used in sewer design but is probably the largest project to which this method has been applied.

American Wood Preservers' Association Discusses Wood-Block Paving

A half-day's session of the annual meeting of the American Wood Preservers' Association, held in New York City, Jan. 23 to 25, was given over to a discussion of wood-block paving. A committee report on service tests of wood-block pavements gave data of value on the history of existing pavements as old as 19 years.

The regular committee on wood-block paving reported the specifications adopted by the joint committee, which met in Brooklyn, N. Y., in September, 1916. These joint-committee specifications have already been accepted by the American Society of Municipal Improvements and were accepted as a part of the progress report of the Road Materials Committee by the American Society of Civil Engineers at the recent annual meeting.

These specifications are practically the same as those drawn by the committee of the American Wood Preservers' Association and submitted at the 1916 annual meeting. This committee differs from the opinion of the joint committee concerning the method of computing the absorption of the preservative, and it does not approve the use of sand filler or sand cushion.

The committee expressed the opinion that, if the new specifications were carefully followed, the resulting street would not bleed excessively, nor should there be serious expansion troubles. The method of forcing in the oil should give the maximum penetration obtainable with the absorption used. These specifications require from 25 to 50% more time than is commonly required for creosoting blocks, but it was felt that the possibility of increasing durability and lessening expansion and bleeding troubles warranted this. From 10 to 12 hr. is required to treat properly Southern pine blocks by the new specifications.

The European practice of laying the blocks directly on a smooth concrete base was commended, particularly that method in which the blocks are either dipped in pitch immediately before laying or where they are set in hot pitch swabbed upon the concrete base. Recent examination of some old pavements so constructed furnished the most convincing argument in favor of that method. Where this type of construction has been abandoned, it has been done solely on account of the fact that it was thought possible to reduce the cost of construction without detrimental effect. The increased cost has been the chief obstacle to its more general adoption.

Within the last two years a new method has been introduced, which the committee believes to be of great importance to the future of the industry. It consists simply in coating the smoothly finished concrete base with bituminous cement and allowing this to get cold and harden before attempting to set the blocks on it. The expedient of allowing cement first to cool and harden before setting the blocks removes the objection of high cost and also removes the objection in regard to the difficulty of replacing faulty blocks. Furthermore, it accomplishes the same results as if the blocks had actually been set while the pitch was still hot, as it is found that after a day or so the blocks all adhere firmly to the base.

A fight was made by several manufacturers against the preliminary steaming of both air-seasoned and green timber, which is the distinguishing feature of the new specifications. It was contended that the two to four hours of preliminary steaming was not only unnecessary in the case of air-seasoned timber, but was an actual detriment as well as a useless expense. The committee defended the steam-treatment clause of the specifications as necessary to obtain a thorough distribution of the preservative and to swell the blocks to their normal size. The fact was emphasized that in treating wood paving blocks special conditions were to be met and that this must be done by special methods which would not apply to timber preservation in general. The preliminary steaming treatment was claimed to be the chief means of curing both bleeding and expansion troubles. After considerable debate the committee won its contention, and the report was adopted.

Canadian Engineers' Society Looking to Its Internal Development

A marked movement in the Canadian Society of Civil Engineers was manifested at the annual meeting in Montreal, Jan. 23 to 25, for the internal development of the society to increase its benefits to members and its outside influence.

The valedictory address of the retiring president, G. H. Duggan, was devoted to this. He referred to the numerous complaints of members who were not satisfied that everything possible was being done. First, he presented statistics of the distribution and growth of membership since the society's formation, to show that Montreal was still the most central location for headquarters. He recommended finding some means of keeping distant members in touch with society activities and making them

bear a share of directing the work. To this end, he suggested (1) more frequent meetings of the council and more certain district representation; and (2) quicker printing of papers and publication of a monthly bulletin. Better service would require more funds, and he suggested a considerable increase in the fees of members resident near headquarters, a small increase to associate members, but no increase for juniors or students. More publicity was recommended as calculated to extend the influence of the society, so that the value of engineering advice would be wider recognized. Such efforts were commended as those of the Montreal member ratepayers who had reported on the local aqueduct-power scheme (as noted in *Engineering News*, Nov. 30, 1916).

A special Committee on Society Affairs (composed of three members from each outlying district and six from headquarters, and asked for by the last annual meeting to bring in recommendations for internal improvements) made a progress report in which several propositions were placed before the annual meeting. Of these the following were adopted and will go into effect through the regular machinery:

(1) The inclusion in the list of members of a geographical distribution by districts; (2) the creation of a new class of membership to be known as "retired members," who shall be over 65 years of age and have been corporate members for over 20 years, the annual fees for them being nominal; (3) the publication of a monthly journal; (4) the elimination of interest charges on annual dues for the first six months of the current year and a fixed charge of 50c. for each six months' period thereafter; (5) systematic publicity in the public press; (6) a systematic effort to have recognized university engineering professors identified with the society and to secure coöperation of universities; (7) the engagement as soon as practicable of a secretary who will devote his whole time to the society; (8) the election of the nominating committee and of the council by districts; (9) the encouragement of more general use of the society's standard specifications; (10) the redrafting of the entire bylaws; (11) the systematic collection and filing of the important engineering reports of Canada, Great Britain, France and the United States; (12) the appointment of a committee to take cognizance of and report upon all public questions of legislation which may appear to be contrary to sound engineering practice or to the interest of members; (13) the obtaining of annual grants from Dominion and provincial governments.

The proposition to change the name to "Canadian Institution of Civil Engineers" or "Canadian Institution of Engineers" was debated, but no action was taken. The meeting approved the council's stand for the limitation of employment of alien engineers and for closer attention to expulsion of undesirable members.

The report of the Finance Committee showed total receipts for the year 1916 of $23,727 and total expenditures of $20,085. The total receipts were about $1000 in excess of the next highest year (1912), due to the better collection of arrears. This good showing was made in spite of the fact that there were 678 members in war service.

Technical-Committee Reports

The Committee on Roads and Pavements brought in specifications for crushed stone, gravel and sand for roadwork, which were adopted as the recommended specifications of the society. The committee is still collecting data on the construction of pavements throughout the Dominion and is engaged in drafting specifications for the supply of bituminous materials.

The Committee on Steel Bridge Specifications reported the preparation of a draft of specifications for highway bridges, which specifications are to be sent out to branches for comment or approval as one step in the preparation of standard specifications of the society.

The Committee on Sewage Disposal and Sanitation recounted its efforts to have provincial boards of health require engineers' approval of plans for sewage works, but reported that it had not been able to accomplish much.

The various committees were continued (including those on conservation, education, concrete, and steam-boiler specifications), the Steel Bridge Committee being empowered to add to its number representatives of the various districts, and the Committee on General Clauses being asked to reorganize for the completion of its work. A new committee was asked for—one on portland-cement specifications.

J. S. Dennis, Assistant to the President, Canadian Pacific Ry., was elected President; J. M. R. Fairbairn, Assistant Chief Engineer, Canadian Pacific Ry., and C. N. Monsarrat, Chairman, Board of Engineers, Quebec Bridge, were elected Vice-Presidents.

Illinois Engineers Widen Activities

The two most prominent features of the annual meeting of the Illinois Society of Engineers were the decisions to extend the scope of the Society by coöperation and affiliation with semi-technical and nontechnical persons and associations, and to organize sections dealing with individual branches of engineering work. Thus the affiliated membership will provide for association with lawyers, contractors, municipal officers and others who are interested in and closely related to engineering matters. The sections will include both the engineer members and the affiliated members in such lines of work as land drainage, good-roads promotion and management of municipal engineering properties. Further than this, the Society will seek active coöperation with various technical and promotional organizations, such as local engineering clubs, good roads associations and city-planning commissions.

In the more technical part of the proceedings it is of interest to note the particular attention devoted to the need of engineering advice in the small towns. This point of view was dealt with in three papers written independently and covering different subjects. Although the individual engineering works in such towns are relatively small, they are of importance to the community and in the aggregate they represent considerable professional and financial importance. Thus the Water-Supply Committee stated that about 90% of the new water-works built in Illinois during the past three years have been in places of less than 2000 population. In such cases the supply and distribution systems are planned largely by local committees, and engineering advice is at a minimum. The report showed the economic advantages of engineering advice in regard to both the design and construction of these small water systems.

Maintenance of engineering works in these small towns is largely neglected, and the report above noted suggested the economy of employing engineers to make semi-annual inspections of the water-supply systems. On the same lines, papers by M. H. Brightman (city engineer of Elgin) and F. C. Lohman (city engineer of Champaign) suggested the wisdom of making the necessary expenditure for proper inspection and maintenance of sewerage systems and street paving, and for competent control of the operation of sewage-disposal plants.

A subject of rather special character was "Engineering Ethics and Engineers' Fees," the matter of fees receiving

the larger share of attention. E. E. R. Tratman (*Engineering News*) remarked that in this respect the practicing engineer is rather in a dilemma. On one hand he has to consider the advisability and possibility of obtaining larger fees, and on the other hand he has to consider the demands for higher pay for his engineering assistants. The question of engineering professors undertaking private practice was touched upon, and the report pointed out that this was unobjectionable if subject to proper curb by the university or college authorities, and if the charges made are approximately the same as those of practicing engineers.

The Illinois structural engineers' license law was reviewed in one of the reports, which showed the interesting fact that while the legislature passed the bill it failed to make an appropriation for the expenses of the board of examiners. The members of the board were public-spirited enough to do the work and pay their own expenses until conditions were relieved, while the Western Society of Engineers gave the use of its rooms and staff. The first examination under this law was held at the University of Illinois in October, 1916.

The election of officers for 1917 resulted as follows: President, W. D. Gerber (Chicago); Vice-President, J. G. Melluish (Bloomington, Ill.). The next meeting will be held at Quincy, Ill., in 1918.

National Foreign Trade Convention

The fourth annual convention of American manufacturers and merchants interested in foreign trade was held at Pittsburgh, Jan. 25 and 27, and was attended by about 1200 delegates from all parts of the United States. A special train brought over 100 from the Pacific Coast. The most important topic considered was the condition of world trade after the war; and there was general agreement that the United States will have to play a leading part in the restoration of Europe and that this will create a great demand for American goods abroad for some years to come.

It was urged that in carrying on this trade, American business men should practice such fair dealing and cultivate such friendly relations with their customers abroad that they may be able to continue to do business there after the urgent stress has passed. In order that this American export trade shall continue, however, it is absolutely necessary that American investors shall be willing to purchase foreign securities. Eventually, of course, the imports of the United States must approach its exports in value, for there is not gold enough in existence to permit for any long time the payment in gold for such a vast surplus of American exports as has gone abroad this year. It will be years, however, before Europe will be in condition to send imports to the United States in such volume as in the past; and during this period the international trade balances must be largely settled by loans from American investors to European governments or their purchase of the securities of foreign corporations.

Coöperation in foreign trade by associations of manufacturers was discussed at much length. While coöperation is to some extent dependent on the passage of the Webb bill, now before Congress, it developed that a great deal of coöperative work is now being done.

An evening session was held to discuss commercial education for foreign trade. The most effective work of this sort appears to be done by the schools for training men now in business, rather than by special courses in high schools and colleges. In order to reach the efficiency of the Germans in this field, however, young men must be given a thorough training in the language, history and customs of a particular country and must go there to make it their permanent home. There is at present a great scarcity of men experienced in foreign trade and the further development of American export business is limited by this lack.

The need of developing an American merchant marine was emphasized by the devotion of one entire session of the Congress to this subject. At present the shipping business is prosperous as never before. Of the 50,000,000 tons of merchant shipping of all nations existing at the outset of the war, only about half is now available for use. Casualties of the war and the sea, taking of merchant vessels for government service and interning of vessels carrying the flags of the Central Powers account for the other half. Opinions differ as to how short the carrying capacity of the world's merchant marine will be at the end of the war, because no one knows how much traffic will be then offered for transport. The judgment of experts, however, is that there will be a shortage of 5,000,000 to 10,000,000 tons and it will take the shipyards of the world several years to restore the world's merchant fleets to normal size.

At present anyone can run ships at a profit. Eventually world-wide competition will reduce ship earnings to the low rate that existed before the war; and unless the United States vessel can be operated as cheaply as the ships under foreign flags, the shipping industry must have some form of government aid or the American flag will again disappear from the seas. The task of the newly appointed U. S. Shipping Board is to find the best plan for this country to adopt to restore its merchant marine.

Water and Street Transportation in Conflict at Pittsburgh

The citizens of Pittsburgh were aroused last week over the question whether the city should be compelled to rebuild its bridges over the Allegheny River so as to afford a greater clearance for navigation. Secretary of War Baker announced that arguments on the question must close by Jan. 29. The Citizens Anti-Bridge Raising Organization conducted a whirlwind campaign to secure signatures protesting against the enforced raising of the bridges. The Board of Directors of the Pittsburgh Chamber of Commerce voted unanimously to oppose the raising of the bridges, and this action was indorsed at a special meeting of the chamber by a vote of 293 to 66.

The ground for the local protest is, first, the expense involved, variously estimated at $3,000,000 to $12,000,000; and second, the permanent burden on the enormous traffic passing over the bridges, due to requiring every pound of weight to be lifted 10 to 20 ft. higher to pass over the bridges after raising, together with the difficulties involved in steeper grades on the approaches.

If the comparison is between the traffic over these bridges and the present traffic on the river under them, then the raising of the bridges could not be justified, for the present traffic on the Allegheny is insignificant. There is, however, some reason to believe that the rivers

at Pittsburgh may in future play a more important part in commerce than they have ever done. The congestion on the railways in the Pittsburgh district is very serious. Yards and terminals are crowded to capacity; real estate is too costly to permit of much enlargement. There is some reason to believe that the rivers may be made use of more largely to distribute coal, coke, ore, etc., within the district and would be valuable in the relief they would afford to the congestion on the railway lines to an extent not measured by the amount of tonnage handled.

To develop this traffic, however, alterations in the bridges are necessary, for some of the bridges that are near each other have their piers so staggered that a boat passing between the piers on one bridge is headed straight for the piers of the bridge below. If a bridge must be rebuilt to bring its piers in proper position, it might as well be placed at a proper elevation.

It is admitted that the former proposal that the bridges should be raised to give a clear height of 45 to 50 ft. was not justified, for it has been proved possible to build satisfactory stern-wheel towboats with a height of 28 ft., and the bridges ought not to be made higher than necessary, on account of the burden placed on the traffic over them. That authority rests in the Federal Government to order the bridge alterations solely with regard to the convenience of navigation is undoubted; but the strict legal view that the traffic over a waterway must always yield to the demands of the navigator of the waterway, because he has prior rights of use, is not insisted on now as much as formerly.

It seems probable that the best solution of the Pittsburgh dispute may be found in a compromise. That the present bridge piers are an obstruction to navigation is admitted even by the opponents of bridge raising. It ought to be possible to work out a program that would provide reasonable facilities for developing navigation on the Allegheny, without imposing undue hardships on the traffic and the taxpayers of Pittsburgh.

Worcester Sewage-Works Enlargement

Pressure is being brought on Worcester, Mass., to enlarge and alter its sewage-treatment works so as to discharge less polluting matter into the Blackstone River. The movement seems to have been started by an application to the State Department of Health to permit the sewage from the Worcester Insane Hospital to be discharged through the sewers of the City of Worcester. An investigation of the Worcester sewage-works led the department to ask the city authorities why the department should not order the immediate construction of works which would treat the sewage to the satisfaction of the department. It was intimated that works along the line of Imhoff tank experiments the city had been conducting for some time would be satisfactory. The city authorities plead for an opportunity to carry further some activated-sludge tests under way. The State Department has granted a limited time for this purpose, but has filed with the Legislature a report, now in the hands of the State Printer, recommending the authorization of bonds for the construction of adequate sewage-works. Representatives down the Blackstone River have introduced two or more bills designed to force action. One of these requires that the sewage of Worcester must be treated to a satisfactory degree and that when the removal of organic matter, as indicated by albuminoid ammonia, falls below 90% unnecessary pollution shall be considered to exist.

Dumping Goods on American Market

There has been a great deal said about the danger of European manufacturers "dumping" low-priced products on the American market as soon as the war closes. W. W. Nichols, Chairman of the American Commission, in his address at the National Foreign Trade Convention at Pittsburgh last week said: "There are many reasons why dumping low-cost products into our markets appears not only improbable, but impossible for many years to come." He closed his address with a most significant revelation, possibly prophetic of the coming of a better era in international relations:

> Added to the warm sympathy unanimously accorded our mission by the great minds of France, Lloyd George, who is accepted as the practical dictator of British affairs and probably therefore in a large sense the exponent of the best British opinion, expressed the desire that what we hoped to do with France might likewise be done not only with Great Britain, but even with the Central Powers after the settlement of present "differences," for, as he magnanimously asserted, "the world is big enough for all of us."

Detroit Needs $16,000,000 of Sewerage improvements, including $10,000,000 at once for sewers in 31 sq.mi. of annexed territory and $6,000,000 for sewage-treatment works which can wait a few years, says Clarence W. Hubbell, the new City Engineer. An attempt is to be made to get the money for the sewers at once.

The New Colorado River Intake Gate for the main canal of the Imperial Irrigation District ("Engineering News," Jan. 18, 1917, p. 124) will be built by the Ross Construction Co., of Sacramento, Calif. The contract price is $268,000. C. K. Clarke, Calexico, Calif., is chief engineer of the Imperial Irrigation District.

Free Engineering Services to Minnesota municipalities are requested in the resolution of the League of Minnesota Municipalities adopted at its meeting, Oct. 19, 1916, which recommends that "steps be taken to have an engineer of maturity and wide experience in municipal work added to the faculty of the State University Extension Department." It is reported that the Regents of the University of Minnesota have provided in the budget to be submitted to the legislature for a consulting civil engineer in the University Extension Department, whose services will be free to all Minnesota cities and towns.

Wrecking the Old Spans of the Omaha Bridge of the Union Pacific Ry. is to be done in an interesting manner. These spans now stand on timber piers alongside the new spans placed on the original piers, as described in "Engineering News," Jan. 18. A traveler, which will be installed on the top of the trusses of the new spans, will strip the floor system and the bracing between the old trusses. Then these latter trusses will be pulled over close to the new structure and supported from it, while the members are removed through the new trusses. In this way no falsework will be required under the four old spans. The work of removal will be done by the American Bridge Co.

The Million-Dollar Road Fund appropriated by Congress to assist the development of the national forests has been allotted as follows: Alaska, $46,354; Arizona, $58,604; Arkansas, $9803; California, $140,988; Colorado, $62,575; Idaho, $108,730; Montana, $70,042; Nevada, $19,296; New Mexico, $42,495; Oregon, $128,111; South Dakota, $8092; Utah, $41,167; Washington, $91,944; Wyoming, $40,684. A total of $9995 has been allotted to Florida, Michigan, Minnesota, Nebraska, North Dakota and Oklahoma. The group of Eastern states—Georgia, Maine, New Hampshire, North and South Carolina, Tennessee, Virginia and West Virginia—in which the Government is purchasing lands for national forests receives $21,120. In making allotments, 10% of the amount available for 1918 is withheld as a contingent fund. One-half of the remainder has been apportioned among the states in amounts based on the area of the national-forest lands in each state, while the other half has been allotted on a basis of the estimated value of the timber and forage resources that the forests contain.

A Chicago Subway System built by private capital is proposed by the Chicago Subway, Arcade and Traction Co. The company has introduced an ordinance granting a 30-yr. franchise for about 60 mi. of subways. Half the system would be completed in 2½ yr. and the remainder in 5 yr. The structures and equipment are to revert to the city without cost at the expiration of the franchise. Two other ordinances include a 20-yr. franchise for an outer harbor, utilizing the material excavated from the subways, and a 15-yr. franchise for warehouses and a bridge at the mouth of the Chicago River. The company has requested the City Council to have these ordinances put on the ballots at the April election.

Tunnel Workers Get Hero Award—Four tunnel workers in the West Side Water Intake Tunnel, Cleveland, Ohio, were awarded hero medals by the Carnegie Hero Fund Commission for bravery in rescue expeditions after the gas explosions in the crib heading of the tunnel on July 24. The tunnel at that time was full of afterdamp and marsh gas, and in two rescue parties ten or twelve men perished by asphyxiation. The four men who received medals went into the tunnel several times while it was in this dangerous condition, and rescued a number of members of the parties overcome in the tunnel. The names of the heroes are Thomas J. Clancy, William J. Dolan, James J. Keating, and James S. McGrath.

Radical River Straightening Plans are being worked out for the Cuyahoga River, Cleveland, Ohio, by an engineering committee that unites the principal interests concerned in previous planning. The local U. S. Engineer Officer, the county engineer, the city engineer, and the former city river and harbor engineer, are joined on the committee, which is working under the auspices of the local Chamber of Commerce. A plan has been worked out by this committee which is more radical than any previously proposed. It would make the river practically straight from the mouth to a point above the Wheeling & Lake Erie bridge, thus covering the worst-curved part of the river. It would also clear up the serious situation at the location of the proposed Lorain-Huron viaduct, where at present satisfactory pier location and bridge alignment are impossible, so that the construction of the bridge, money for which was authorized by the voters, is held up.

A Bridge Across the Hudson River at Castleton, 10 mi. south of Albany, is to be built by the New York Central & Hudson River R.R. An application for the approval of the plans for the bridge is now pending before the Secretary of War. The bridge was originally designed with spans 400 ft. long; but to meet any possible objection as to interference with navigation, the length of the channel span has been increased to 600 ft. An additional channel will be dredged by the railroad company under the 400-ft. span that forms the eastern part of the structure. The traffic of the New York Central lines is at present carried across the river at Albany on a low-level bridge, with a heavy grade from the bridge westward and another heavy grade on the eastward on the Boston & Albany road. Heavy freight trains on these grades require one and two pusher engines. The new bridge, if built, will be a high-level bridge, permitting easy grades and connections on both the east and the west shore. With the exception of the Poughkeepsie bridge, this will be the only bridge across the Hudson River south of Albany.

PERSONALS

George Freis has been appointed County Engineer of Iowa County, Iowa, with office at Morenzo, succeeding Byron Goldthwaite.

Le Roy Greenalch has resigned as City Engineer of Rensselaer, N. Y., to accept a position with the New York State engineering staff.

Clifford Goplerud has been made County Engineer of Mitchell County, Iowa, with headquarters at Osage, succeeding B. B. Hanson.

F. D. Pearse has been appointed County Engineer of Franklin County, Iowa, with headquarters at Hampton, succeeding A. G. Baker.

J. W. Mercer, formerly County Engineer of Lucas County, Iowa, has resigned to become County Engineer of Ringgold County, with headquarters at Mt. Ayr, Iowa.

T. H. Gatlin, Assistant Chief Engineer of Maintenance-of-Way of the Southern Ry., has been made Assistant to the Vice-President, with headquarters at Washington, D. C.

John N. Wilson has resigned as Assistant County Engineer of Washington County, Pennsylvania, to become Construction Engineer of the Hazel-Atlas Glass Co., Wheeling, W. Va.

Alva J. Smith, Resident Engineer on construction of the Emporia, Kan., water-purification plant has been appointed City Engineer and Superintendent of the Water Department.

B. Herman, Chief Engineer of Maintenance-of-Way of the Southern Ry., Washington, D. C., has been appointed Chief Engineer of the Lines East of Cincinnati, with headquarters at Washington.

C. E. Stone, for the past 14 years with the civil engineering department of the Pittsburgh & Lake Erie R.R. at Pittsburgh, Penn., has opened an office at 1902 Benedum-Trees Bldg., Pittsburgh, for private practice.

N. W. Storer, F. Am. Inst. E. E., General Engineer of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., has been elected President of the Veteran Employees Association of the company.

William A. Cattell, M. Am. Soc. C. E., **Henry S. Howard,** M. Am. Soc. M. E., and **Raymond Ashton** announce their association under the firm name of Cattell, Howard & Ashton, Engineers, 68 Post St., San Francisco, Calif.

M. Helston, recently Superintendent of the Virginia (Minn.) division of the Duluth, Winnipeg & Pacific Ry., has been made Superintendent of the Calgary division of the Canadian Northern Ry., with office at Calgary, Alberta.

C. A. Forter, formerly Assistant City Engineer and more recently Superintendent of the municipal incinerating plant at Topeka, Kan., has entered the employ of the John Baker, Jr., Asphalt Distributing Co., Kansas City, Mo.

Curtis Dougherty, former Chief Engineer of the Cincinnati, New Orleans & Texas Pacific Ry., Cincinnati, Ohio, has been appointed Chief Engineer of the Lines West of Cincinnati of the Southern Ry., which has absorbed the C., N. O. & T. P.

C. S. Rindsfoos, President of the U. S. Purchasing Corporation, New York City, has become associated with the Jarrett-Chambers Co., Inc., Engineers and Contractors, New York. He was formerly Secretary and Treasurer of the Foundation Co.

Fred Aphüls, M. Am. Soc. M. E., **Halbert P. Hill** and **T. Harold McCreery,** M. Am. Soc. M. E., have formed the firm of Aphüls, Hill & McCreery, Inc., with offices at 112 West 42d St., New York City. The new firm will specialize in the design and construction of industrial power plants and refrigerating plants.

Henry Lindenkohl has been appointed Engineer of Construction of the American Locomotive Co., with headquarters at Schenectady, N. Y. He was born in New Jersey in 1883 and is a 1905 graduate of Stevens Institute of Technology. He has been with the American Locomotive Co. since 1905, when he was an inspector on building construction.

John J. Carty, President of the American Institute of Electrical Engineers, Chief Engineer of the American Telephone and Telegraph Co., New York City, has been commissioned Senior Major in the Signal Officers' Reserve Corps of the United States Army. This is a special distinction for it makes him the ranking officer of the Signal Corps Reserve, which is to be organized under the provisions of the National Defense Act. of June 3, 1916.

Fred Bennett, for more than four years Highway Engineer of Bexar County, Tex., of which San Antonio is the county seat, resigned his office Jan. 25 to become effective not later than Feb. 10, to become one of the members of the firm of Julian C. Feild & Co., Consulting Engineers, Denison, Tex. Mr. Bennett was associated with Julian C. Feild during 1910-11 during the building of the Denison road system, after which he went to San Antonio to become Highway Engineer for Bexar County. During his incumbency in that position he built the Bexar County highway system at a cost of slightly over $1,500,000, and since the completion of the road system has inaugurated an effective maintenance system for the county roads.

A. L. Humphrey, M. Am. Soc. M. E., First Vice-President and General Manager of the Westinghouse Air Brake Co., Pittsburgh, Penn., has been elected President of the Union Switch and Signal Co., in accordance with merger proceedings of the two companies. Hereafter he will assume the executive work of both companies. He was born in Erie County, New York, but his boyhood was spent in Iowa, where he received a common school education. At 22 years of age he organized a machine shop and foundry at Seattle, Wash., which has since developed into the Moran Iron Works. Next he became a Division Foreman on construction of the Mojave division of the Central Pacific R.R. Afterwards he was Master Mechanic and Superintendent of Motive Power of the Colorado Midland Ry. He joined the Westinghouse Air Brake Co. in 1903 as Western Manager, leaving the office of Superintendent of Motive Power of the Chicago & Alton R.R. He was made General Manager in 1915 and Vice-President in 1910.

OBITUARY

J. D. Allen, a civil engineer of Chicago, Ill., died Jan. 17 at Tuscola, Ill., where he had been assisting the County Surveyor on the Akaw drainage project.

Robert Sherrard Orr, Assoc. Am. Inst. E. E., Vice-President and General Manager of the Duquesne Light Co., Pittsburgh, Penn., died Jan. 28, aged 49 years. He was born in Clarion County, Pennsylvania, and educated at the public schools and at Washington and Jefferson College, where he was graduated in 1891. He was a school teacher in Allegheny until 1904, when he became General Contracting Agent of the Allegheny County Light Co. He was soon made General Superintendent and in 1914, General Manager.

Eugene L. Hurley, Assistant to the Valuation Engineer of the New York Central R.R. Lines East of Buffalo, died on Jan. 6, as the result of an operation. He was born in Rahway, N. J., Aug. 4, 1875. He was graduated from Rutgers College and entered the services of the New York Central & Hudson River R.R. in March, 1900, as Assistant Engineer, Maintenance-of-Way Department. In 1911 he had direct supervision of the forces engaged in the so-called Swain valuation of the Lines East of Buffalo, and in 1913 he joined the present valuation forces.

Frank Gilbert, a noted engineer of Montreal, Que., died on Jan. 23, in his 70th year. Early in life he became a member of the firm of E. E. Gilbert & Sons, engineers and contractors, known also as the Gilbert Blasting and Dredging Co. and the Canada Engine Works. On the death of his father he became the senior partner. This company was the first in Canada to introduce the chain tug for submarine drilling. It executed important and difficult pieces of engineering work in connection with the St. Lawrence canal system. Mr. Gilbert is survived by his widow, one son and one daughter.

Richard B. Dole, Chemist in Water Resources Branch of the United States Geological Survey, died Jan. 21, at his home in Washington, D. C. He was born in Portland, Maine, May 8, 1880, and was graduated from the Portland High School in 1898. In 1902 he received the degree of Bachelor of Arts, magna cum laude, from Bowdoin College, and in 1903 he took a graduate course in chemistry at the Massachusetts Institute of Technology. In June, 1903, he was appointed engineering aid in the United States Geological Survey; he was successively aid, assistant hydrographer, assistant engineer, assistant chemist, and chemist in the Water Resources Branch. He was a member of many societies and wrote many reports and papers on the quality of waters, including a chapter on water for industrial purposes in the "Manual of Industrial Chemistry" by Rogers & Aubert. A widow survives him.

John Fletcher Moffett died at a private hospital in New York City Jan. 28. He was taken ill with the grip early in the month and complications developing he was removed to the hospital on Jan. 16. He was born Apr. 15, 1841. He went to Watertown, N. Y., as a young man and entered the Watertown Bank and Loan Co., where he continued until 1882, when he associated himself with Frank A. Hinds and Henry C. Hodgkins, Civil Engineers, under the firm name of Hinds, Moffett & Co. In 1885 Mr. Hinds retired and the firm became Moffett, Hodgkins & Clarke. The firm engaged in the construction of railroads, water, gas and electric plants in all parts of this country and Canada. Mr. Moffett disposed of his last water, gas and electric properties about four years ago. Of his former partners H. C. Hodgkins, of Syracuse, N. Y., and C. T. Moffett, his son, of New York, survive. He is also survived by his son Earl M. Moffett, of Wilmington, Del., and three daughters.

ENGINEERING SOCIETIES

OREGON SOCIETY OF ENGINEERS.
Feb. 5. Annual meeting in Portland. Secy., Orrin E. Stanley, P. O. Box 973, Portland, Ore.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

NATIONAL LIME MANUFACTURERS' ASSOCIATION.
Feb. 6-7. Annual meeting in New York City. Secy., F. K. Irvine, 537 South Dearborn St., Chicago.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 7-9. Midwinter convention in New York City. Secy., F. J. Hutchinson, 33 West 39th St., New York City.

MINNESOTA SURVEYORS' AND ENGINEERS' SOCIETY.
Feb. 7-9. Annual meeting in Minneapolis. Secy., W. F. Rosenwald, Shubert Bldg., St. Paul.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

AMERICAN ASSOCIATION OF ENGINEERS.
Feb. 8-10. In Chicago at the Hotel La Salle.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

ARKANSAS ENGINEERING SOCIETY.
Feb. 13-14. Annual meeting in Little Rock. Secy., Wm. J. Parkes, Pine Bluff, Ark.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 14-15. Annual meeting in Indianapolis. Secy., W. F. King, Indianapolis, Ind.

WISCONSIN ENGINEERING SOCIETY.
Feb. 15-16. At Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 19-22. Meeting in New York City. Secy., Bradley, Stoughton, 29 W. 39th St., New York City.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb 20-21. Annual meeting in New Haven in Mason Laboratory. Secy., J. F. Jackson, New Haven.

IOWA STATE DRAINAGE ASSOCIATION.
Feb. 20-21. Meeting in Fort Dodge. Secy., M. F. P. Costelloe, Ames.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting in Ames. Secy., J. H. Dunlap, Iowa City.

The Louisiana Engineering Society, at the annual meeting on Jan. 13, elected the following officers: President, A. T. Dusenbury; vice-president, John Klorer; treasurer, Ole K. Olsen; secretary, W. T. Hogg.

The Western Paving Brick Manufacturers' Association, at the annual meeting Jan. 19 and 20 in Kansas City, elected the following officers: President, A. W. Shulthis; vice-president, H. J. Huiskamp; treasurer, Frans Janssen; secretary, G. W. Thurston, Kansas City, Mo. Several papers were presented and a lunch was given at the Baltimore Hotel.

The Nebraska Association of members of the American Society of Civil Engineers was organized on Jan. 5 at Lincoln, at which time the following officers were elected: President, Frank C. Darrow, engineer maintenance-of-way, Burlington R.R.; vice-presidents, Adna Dobson and George L. Campen; secretary, Homer V. Knouse, constructing engineer, Metropolitan Water District of Omaha, Omaha, Neb.

Albany Society of Civil Engineers.—The annual meeting and dinner was held on the evening of Jan. 23 at Keeler's Hotel, Albany, with over 100 members in attendance. Mr. Robert E. Horton was the Toastmaster. Among the after-dinner speakers was William R. Hill, former President of the Society, who gave an interesting résumé of the history of the Society and also of the early history of the American Society of Civil Engineers, which showed that for a long time in its early years the National society had little larger membership than the Albany society had at a similar age.

The Indiana Engineering Society at its recent annual meeting, reported in "Engineering News," Jan. 25, elected the following officers: President, C. F. Harding, Professor of Electrical Engineering, Purdue University; vice-president, W. H. Insley; secretary, Charles Brossmann, Indianapolis. Resolutions were passed favoring the preparation of a bill for licensing structural engineers, or having the architects' bill changed to include the engineers. Other resolutions favored preparing a bill to increase the compensation of county surveyors and to raise the requirements to five years' practical experience or three years in an engineering school and two years' practice.

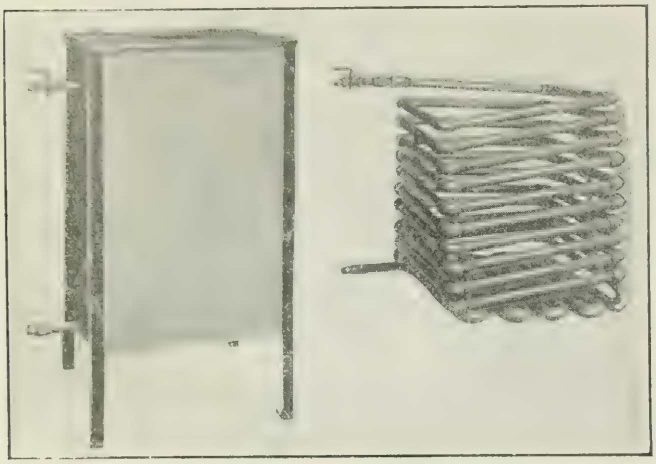
American Wood Preservers' Association—The thirteenth annual meeting was held in New York City, Jan. 23, 24 and 25. The report of the secretary-treasurer showed a net gain in membership during the year of 24. The total membership is now about 300. The report of the Committee on Terminology, giving definitions and descriptions of all the more common methods of timber preservation, was read and adopted. This report gives an excellent summary of timber-preservation methods. The Committee on Specifications for the Purchase and Preservation of Treatable Timber presented a 14-page report outlining: (a) Fundamental principles; (b) selection of treatable timber; (c) preparation of timber for treatment; (d) treatment of timber. This report contains a number of changes to be included in the association's "Manual." The report of the Committee on Promotion and Publicity advocated more individual activity and more general advertising of treated timber. The Committee on Service Tests of Ties and Structural Timber presented a valuable and systematic collection of data, of which a detailed analysis was presented by R. H. Hicks, Engineer of Forest Products, Forest Products

Laboratory, Madison, Wis. The report of the Committee on Plant Operation dealt with methods of measuring the quantity of preservatives used and of determining the volume in a charge of ties, poles or piles, with plant records and ways and the means for reducing fuel consumption. Detailed methods of chemical analysis of different wood preservatives are given in the 65-page report of the Committee on Preservatives. This report was supplemented by a minority report of the subcommittee B on creosote and coal-tar oils, which took issue with the conclusions of the majority report on these preservatives. After much discussion the majority report was adopted. The reports of the Committees on Wood-Block Paving and the accompanying discussion are given elsewhere in this issue. Two papers illustrated by lantern slides were read, one on the "Grouping of Ties for Treatment" and the other on "Bad and Good Handling of Wood." The principal officers elected for the ensuing year are: President, John Foley, Forester, Pennsylvania R.R., Philadelphia, Penn.; Secretary-Treasurer, F. J. Angier, Superintendent of Timber-Treating Plants, Baltimore & Ohio R.R., Baltimore, Md. It was voted to hold the next annual meeting at Chicago, Ill.

Appliances and Materials

Water Heater for Concrete Work

The heater for water used in making concrete or mortar in winter, shown in the accompanying view, is a heavy steel salamander containing a triangular coil of 100 ft. of 1-in. pipe. The heater, which is 24 in. square and 4 ft. high over all, may be filled with soft coal, coke or wood, as may be most convenient. The coil is self-draining and has the lower end fitted for a hose connection, while the upper end is fitted with a cock. Both ends project through the side of the heater or



WATER HEATER FOR COLD-WEATHER CONCRETING

salamander. The device will deliver a steady stream of water at a temperature suitable for use in zero weather. The heater, which has been used by a number of contractors, is made by the C. A. Londelius & Sons Co., 847 West 63d St., Chicago.

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Concrete Roofing Tiles

The Walter concrete roofing tile is being introduced in Chicago, mainly for residences and small buildings, and also for industrial buildings. The tiles are 8x12 in., with corrugated surfaces that interlock, and have lugs by which they are hooked to strips spaced 12 in. c. to c. They are made by the Chicago Concrete Roofing Tile Co.

* * *

Water Regulator and Meter for Concrete Mixer

An automatic water regulator and meter to be attached to concrete mixers has been put on the market by the Anderson Meter Co., Providence Building, Duluth, Minn. It has been successfully used during the past season on work in that city. The device is in effect a centrifugal pump with metering attachment. It can, therefore, be used either as a pump, when motor driven, to fill tanks, sprinkle concrete, etc., or as a regulator of the supply to the mixer. It is operated by throwing the lever shown, the process thereafter being automatic. Desired amounts of water can be set on the gage and the regulator cuts off at the proper point. The device weighs about 75 lb., is 12-in. diameter and can gage automatically

AUTOMATIC WATER REGULATOR AND METER

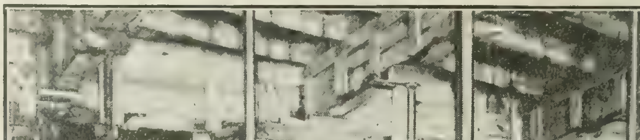
from 1 to 20 gal. of water. In the accompanying figure, the left view shows guard and sprocket wheel on shaft, operating lever in upper right corner; inlet or suction, automatic valve and regulating dial on the left. The right view shows the reverse side, plate removed, disclosing interior.

* * *

Steel Shores for Concrete Forms

The Gemco adjustable shore used for supporting formwork in concrete construction consists of two steel pipes telescoping each other. The 2-in. lower section is 4½ ft. long, with a broad base screwed to the bottom, while its top is fitted with a lever device for raising and adjusting the 1½-in. upper pipe and a gripping device for holding this pipe at any position. A releasing collar allows dropping the upper section of pipe about ½ in. to clear the load; this enables the locking dogs to be released and the pipe lowered into the larger pipe. The upper pipe is ordinarily 9 ft. long. Its top may be fitted with a flat head or with a forked head to receive a timber of the formwork. Special flaring or Y-heads may be fitted also to give ample bearing support under heavy beams.

To avoid the use of wood side-bracing for forms of heavy beams, where rigidity is an important feature, malleable-iron brackets can be attached to each end of this Y-head and a 2-in. vertical channel slipped through this. The channels are adjusted to the desired height and locked by dogs in the



TELESCOPIC STEEL SHORES SUPPORTING FORMS

brackets. They bear against the side of the form and have seats for a timber to carry the ends of the intermediate joints.

The accompanying view shows these steel telescopic shores in use in the construction of an eight-story warehouse of reinforced concrete in New York City. The shores and fittings are manufactured by the Gemco Manufacturing Co., Milwaukee, Wis.

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Old Ohio River Bridge at Louisville—Nearly Fifty Years in Service

Modernization is about to destroy a landmark of bridge engineering, the Louisville bridge across the Ohio River between Louisville, Ky., and Jeffersonville, Ind., used by the Pennsylvania Lines West of Pittsburgh. Its larger part consists of spans of the long-obsolete Fink type. It is one of the few surviving railway bridges having cast-iron members. It has been continuously in railway service for 47 years and now is not worn out, but is forced into the scrap heap by the increase of railway loads and the need for a second track.

In 1872, two years after the completion of the Louisville bridge, Albert Fink, in writing the Chief Engineer's final report, said: "The bridge has . . . stood during that time as severe a test as it can ever be subjected to. Experience so far has not developed any defect either in plan or execution."

The bridge has stood since that early day the test of modern railway traffic, far more severe than any foreseen by Fink. Engineers of the present day will readily grant that it has proved itself remarkably durable and that it bears testimony to the excellent work of the bridge engineers of half a century ago.

In its 47 years of service the bridge has required practically no repairs and no reconstruction or replacement except in the floor system. It has had only three coats of paint since its first field painting.

The bridge is practically a mile long (5250 ft.). It consists of a long succession of deck spans of the truss-rod type, originated by Fink, in spans up to 245 ft. 5 in., and two through channel spans of Warren type with vertical hangers and subtie system. Its top chords are of cast iron—octagonal with a round central hole, the ends squared. Its bottom chords and tension diagonals are of eye-bars, and its posts and compression diagonals of Phœnix columns.

FIG. 1. AN EARLY PHOTOGRAPH OF THE OLD LOUISVILLE BRIDGE, COMPLETED IN 1870
One of the unsymmetrical Fink spans, 12 panels, 180 ft. long, is seen in the foreground; the nearer through span is the 400-ft. Indiana Channel span

Fig. 1 shows the bridge as it was built, and as the larger part of the structure—it is in process of replacement—still appears today. The Portland Canal draw at the Louisville end (see span diagram, Fig. 2) was replaced 15 years ago by a "modern" Pratt truss draw, which except for the difference in type and make-up looks as old now as the rest of the bridge.

The deck spans are typified in all details by the longest, the 245-ft. 5-in. spans of 16 panels, Fig. 3. However, there are 10-panel and 12-panel spans also, and their webbing necessarily is unsymmetrical (see near span in Fig. 1). The sketches in Fig. 4 give the arrangement of posts and truss rods. The 50-ft. approach spans have four panels, the 210-ft. spans 16 panels like the longer ones.

Cast-iron arch floorbeams with iron tie-rods are a special feature of these Fink spans. Their form is

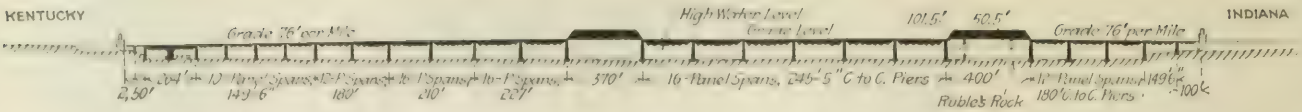


FIG. 2. DIAGRAM ELEVATION OF LOUISVILLE BRIDGE ACROSS THE OHIO RIVER

clearly apparent from the cross-section in Fig. 3. The end of the floorbeam forms the connection block between post and top chord, and the floorbeams themselves constitute also the upper struts of the sway system. Therefore, although the floor loads today are being carried by steel floorbeams (placed 25 years ago), the old cast-iron floorbeams are still in place. The lower struts of the sway bracing are also cast-iron members.

In their 20 years' service the cast-iron floorbeams gave some trouble. Their tie-bars, originally shrunk on, tended to become loose—it was believed because of wear at the pins. Some of them were reshrunk, while others were fitted with turnbuckles. After many years one of the arches broke on account of loose tie-bars; it was not strong enough as a beam to carry the stringer load.

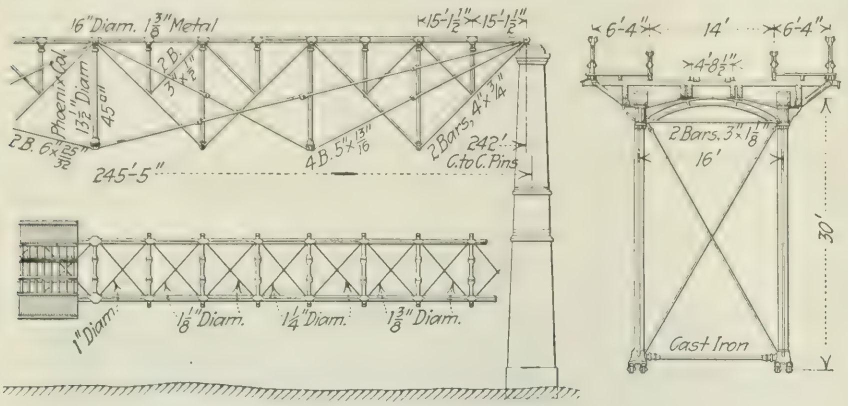


FIG. 3. FINK DECK SPAN OF 16 PANELS, LOUISVILLE BRIDGE

In 1891 the cast-iron floorbeams in all the deck spans were displaced by steel (that is, put out of service, though left in position). A pair of shallow plate-girders was set at each floorbeam, a girder on either side of the arch, with ends resting on the top chords of the trusses.

Wooden Stringers in Service 25 to 35 Years

The original stringers throughout the bridge, on the through spans as well as the deck spans, were pairs of 8x16-in. white-pine timbers. As they rotted out, they were replaced by yellow-pine timbers of the same size. Some time after the floorbeam replacement on the deck spans, however, a start was made in putting in steel I-beam stringers. The stringers of the two through spans and the six deck spans between were replaced by steel in 1895 and 1896. Ten years later the remaining spans were equipped similarly.

In general, the durability of the timber was very satisfactory. The early failure of the wooden stringers was due largely to rotting and crushing at the ends, where they rested on the floorbeams. This rotting and the liability to fire were the reasons for the substitution.

Double-Truss Construction of the Through Spans

The two through-truss spans are most remarkable for their duplex construction. Each side or truss is made up of two identically equal trusses set close, side by side. Why this was necessary may be gathered from the fact that in 1870 the 400-ft. span was "the longest truss girder yet completed in America" and from the heavy sections required in the individual members. The posts, Phœnix columns, range from 5½ to 17 in. in diameter and have sectional areas from 5.7 to 60 sq.in. Members of double the latter size might have been beyond the manufacturing resources of the day, and in any case the details of their connection to the eye-bars would have been very difficult. Probably the same is true of the cast-iron top chords, octagonal sections of 14 in. in diameter, with central circular hole giving 1- to 1½-in. thickness of iron.

The duplex truss construction (see the cross-section in Fig. 7, which shows the complete independence of the component trusses) presented an interesting difficulty. It was necessary to connect the component trusses together and at the same time make each carry its own weight and take a true half-share of the floor load. The former requirement was met by erecting the two trusses separately:

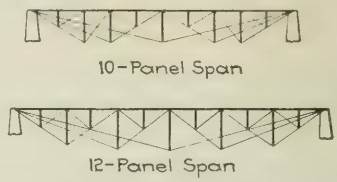


FIG. 4. DIAGRAMS OF FINK TRUSS SPANS

> The trusses on either side of the roadway are now securely connected by bolts and struts; but before being thus connected each was allowed to support its own weight, and assume its natural camber, uninfluenced by any connection with its neighbor. By this precaution the possibility of undue strains from inaccuracy of workmanship was avoided.
>
> It is of interest to note that when thus swung independently no perceptible difference could be observed in the camber of the four trusses, which, while supporting each its own weight, were bolted together without reaming or chipping.

The connection by cast-iron separator "struts" is indicated in Figs. 7 and 8. In the bottom chord it occurs at the ends only, but the floorbeam connections also serve as spacers.

The second problem, equal division of the floor loads, was solved by help of the truss-rod construction of the double 12-in. I-floorbeams. The pair of I's was extended under both trusses and connected to both by similar sets of hangers; and the trussing eye-bars were connected to the I-beams in the center line between the two trusses.

This method of connection appears to have sufficed for equal live-load distribution so far as the major members of the trusses are concerned; the truss separators would help to prevent unequal deflection. But at the subhangers the equal distribution of the single panel load to the hanger bars was not secured, apparently. At any rate a system of equalizer levers was put in at these points 20 years ago, which divides the load equally among the individual hanger bars of the two trusses.

A few details of the truss construction are reproduced in Fig. 8. The general drawing, Fig. 7, shows the form of the portal and sway systems—all cast iron.

A prominent feature of the through spans is found in the eye-bars. The thinnest, which occur in the second panel, are only $\frac{21}{32}$ in. thick in the body (all the bars are 6 in. wide. The heads of the bars are thickened, however, so that they possess lower bearing pressure and better resistance to dishing in the head than might be expected from the dimensions of the bars. The heads were forged separately and welded to the body of the bar.

The stiff diagonals in the middle panel are supplemented by eye-bars extending alongside. This provides for counter stresses. Fig. 7 does not show these counter ties, which indicates the possibility that they were added after the original plans had been drawn.

The only alterations made in these two spans since construction were installing hanger equalizers and providing steel I-beam stringers. Some adjustment of the expansion rollers was required, when these were found to have grooved into their bed plates and rusted fast.

Loads and Stresses; Material

The bridge was designed to carry a rolling load of 2600 lb. per lin.ft. The present-day loads are probably somewhat more than 50% higher. However, the original unit stresses were low, and this accounts for the fact that the bridge has not been fatally overloaded before this. Concerning the unit stresses, Mr. Fink said:

> The factor of safety in the cast-iron chords is from 6 to 7, and in the wrought-iron braces from 5 to 6, by Hodgkinson's formula.
>
> The strain in the wrought-iron tension members is varied according to their position and duty; for example, the suspension and small truss-bars of the channel spans, which are subjected to a maximum load at the passage of each train, have with this load [2600 lb. per lin.ft.] a strain of from 7000 to 8000 lb. per sq.in.; while the bottom chords of these spans, and the main system of the suspension trusses, which rarely, if ever, are subjected to the calculated maximum strain, are proportioned for a strain of 12,000 lb. per sq.in. The other tension members of the bridge are proportioned for intermediate strains, 7000 lb. being the least and 12,000 lb. the greatest strain with a full load.

The iron in the bridge (other than cast) was wrought iron of "not less than 60,000 lb. per sq.in. breaking strength."

On this point of strength, however, interesting figures were obtained by J. C. Bland, Engineer of Bridges, Pennsylvania Lines West of Pittsburgh, in connection with an analysis of the entire bridge in 1901, made to fix the maximum loading that could be used. Of the 6-in. eye-bars forming the lower chord of the trussed floorbeams of the through spans, four were selected at random, taken out, and subjected to full-size test. The results were:

Test	Span	Elastic Limit Lb. per sq.In.	Maximum Strength, Lb. per Sq.In.
1	370 ft.	29,580	46,340
2	370 ft.	30,590	45,880
3	400 ft.	33,320	34,835
4	400 ft.	34,157	42,824

Note. Tests 1, 2 and 4 broke in the head. Test 3 broke in the body of the bar, 12¼ in. from pin center.

Deflection and Camber

All trusses of the bridge were cambered, the amount of erection camber being such as to bring each span into straight condition under full live-load. The flexibility of the Fink trusses appears to have been rather high, as might be judged from their shallow proportions and the slight inclination of the longest truss eye-bars. The longest Fink spans, 245 ft. 5 in. in length, were tested under a train of four locomotives weighing 200 tons; the center deflection was 1¾ in. and the quarter-point deflection 1¼ in.

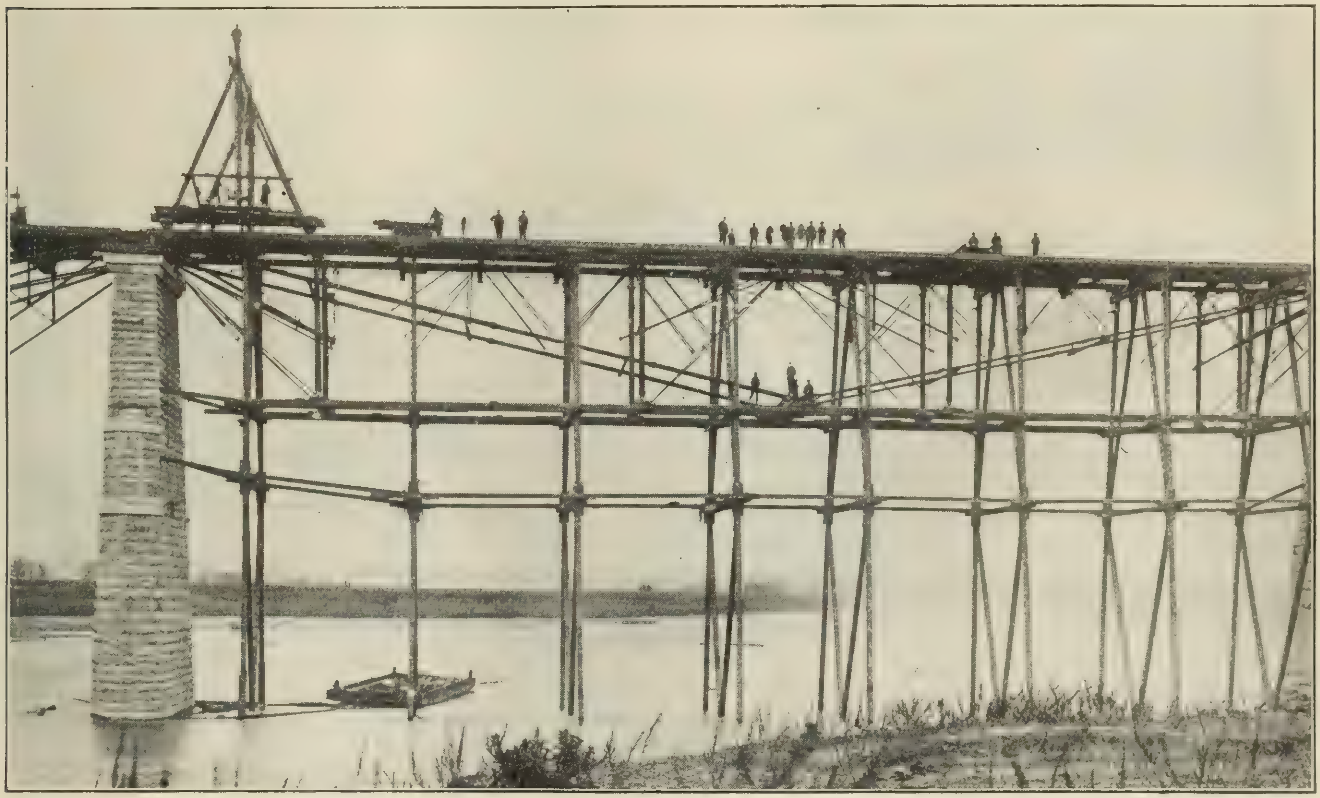


FIG. 5. ERECTION OF ONE OF THE FINK DECK SPANS OF THE LOUISVILLE BRIDGE
Reproduction of an 1869 photograph

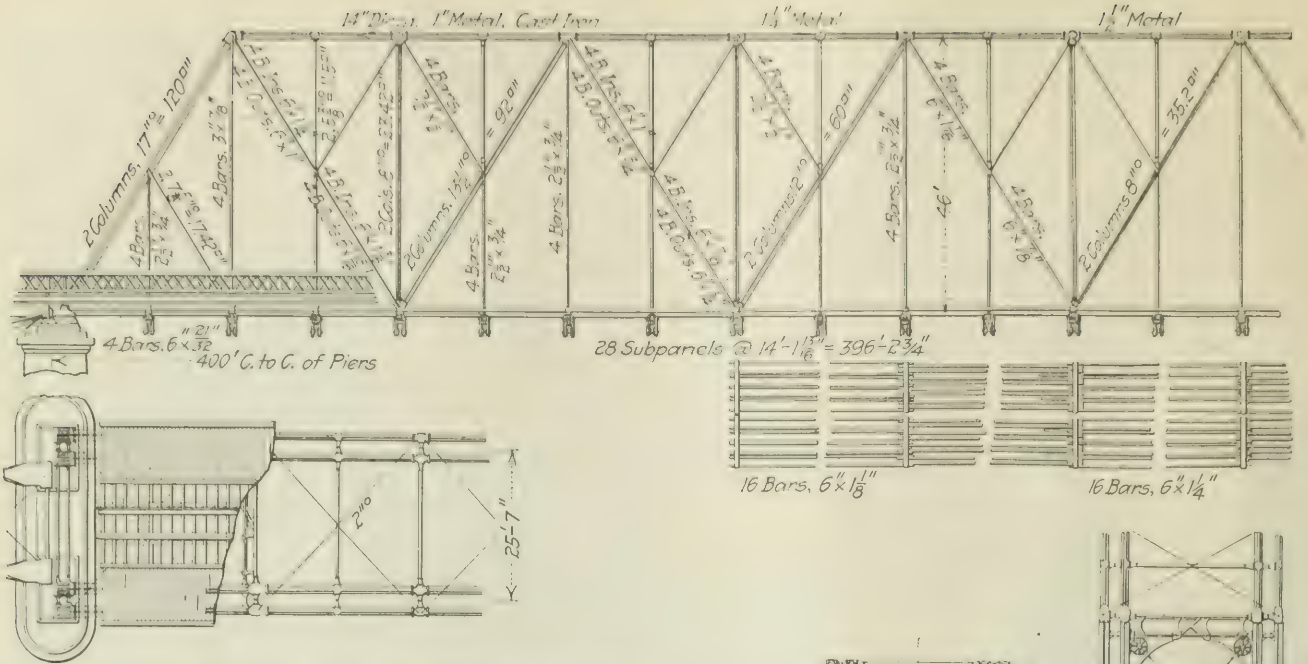
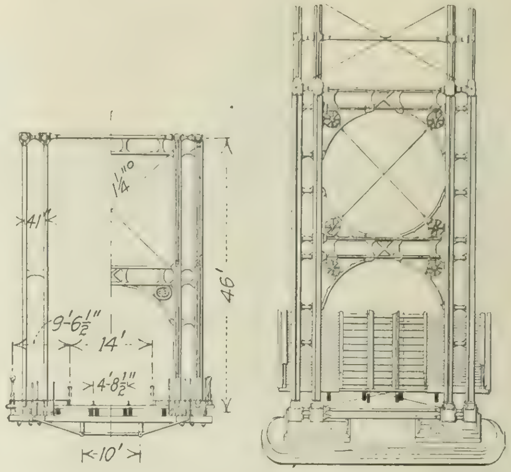


FIG. 7. INDIANA CHANNEL SPAN OF LOUISVILLE BRIDGE



As to the deflections of the through spans, no statement is found, but these may be judged from the amount of camber built in. This camber was provided by making each member shorter or longer by the amount it would extend or compress under maximum load. "In fixing the amount of camber for each span, the design has been to make it such that under a maximum load the span would be straight." But for the Fink trusses the camber was put in "by calculating the length of the chains for a length of post less than the true length by the ordinate at that point."

The camber of the two channel spans is given as 2½ in. for the 400-ft. span and 3¼ in. for the 370-ft. span. The difference presumably is due to settlement of the falsework.

Construction of the bridge began in 1867. Erection of the superstructure was started May, 1868, and finished Feb. 1, 1870. The first train ran over the bridge on Feb. 24, 1870. This was considerably behind time, due to two reasons—delay on the part of the masonry con-

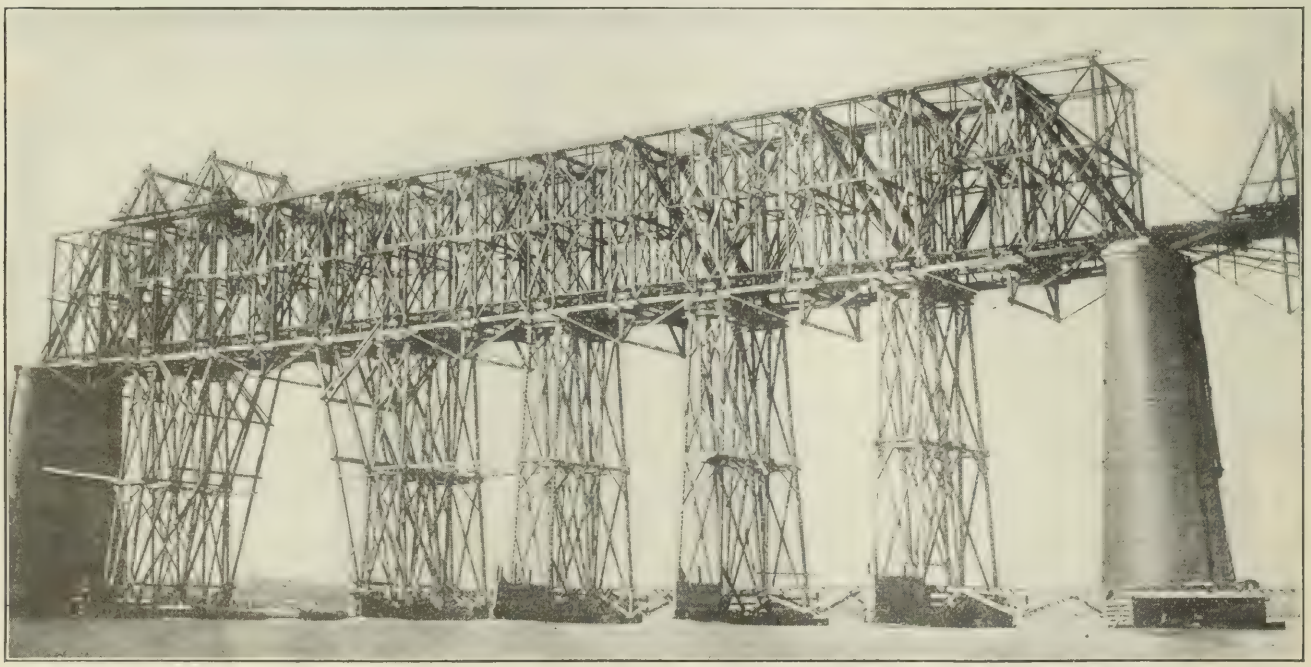


FIG. 6. FALSEWORK AND TRAVELING CRANES USED IN ERECTING THE 400-FT. THROUGH SPAN

tractor (which led to the engineers completing the work by force account) and the loss of the last steel span to be erected. The construction work is well portrayed by the original views, Figs. 5 and 6.

Construction of the Bridge

The piers all rest directly on the river bedrock. A working track supported on 6-ft. square cribs 36 to 40 ft. apart, set diagonally to the current, was bolted down into wedge fastenings in the rock by 4-in. bolts. All masonry and material were handled on this track.

Erection of the Fink spans was managed with the very simple falsework shown in Fig. 5. An elaborate enveloping falsework and scaffolding, however, was required for the through spans. Upper-chord traveling cranes, as can be seen in the photograph, handled the material for these spans.

During the life of the bridge it was painted with one coat in 1877, one coat in 1889 and one coat in 1901, or only three coats during the 47 years from its completion up to date. All these coats (subsequent to the erection coat) consisted of straight red lead and oil, without coloring. The oil was bought raw and boiled on the job.

The last coat of paint was in splendid condition when 11 or 12 years old, which agreed with the previous experience that repainting at 10- or 12-year intervals kept the bridge in perfect shape without pitting, flaking or other defects. However, the repainting due about 1913 was omitted because plans for reconstruction were under way. The result is that, although the paint in general looks good (though rather thin), there are occasional

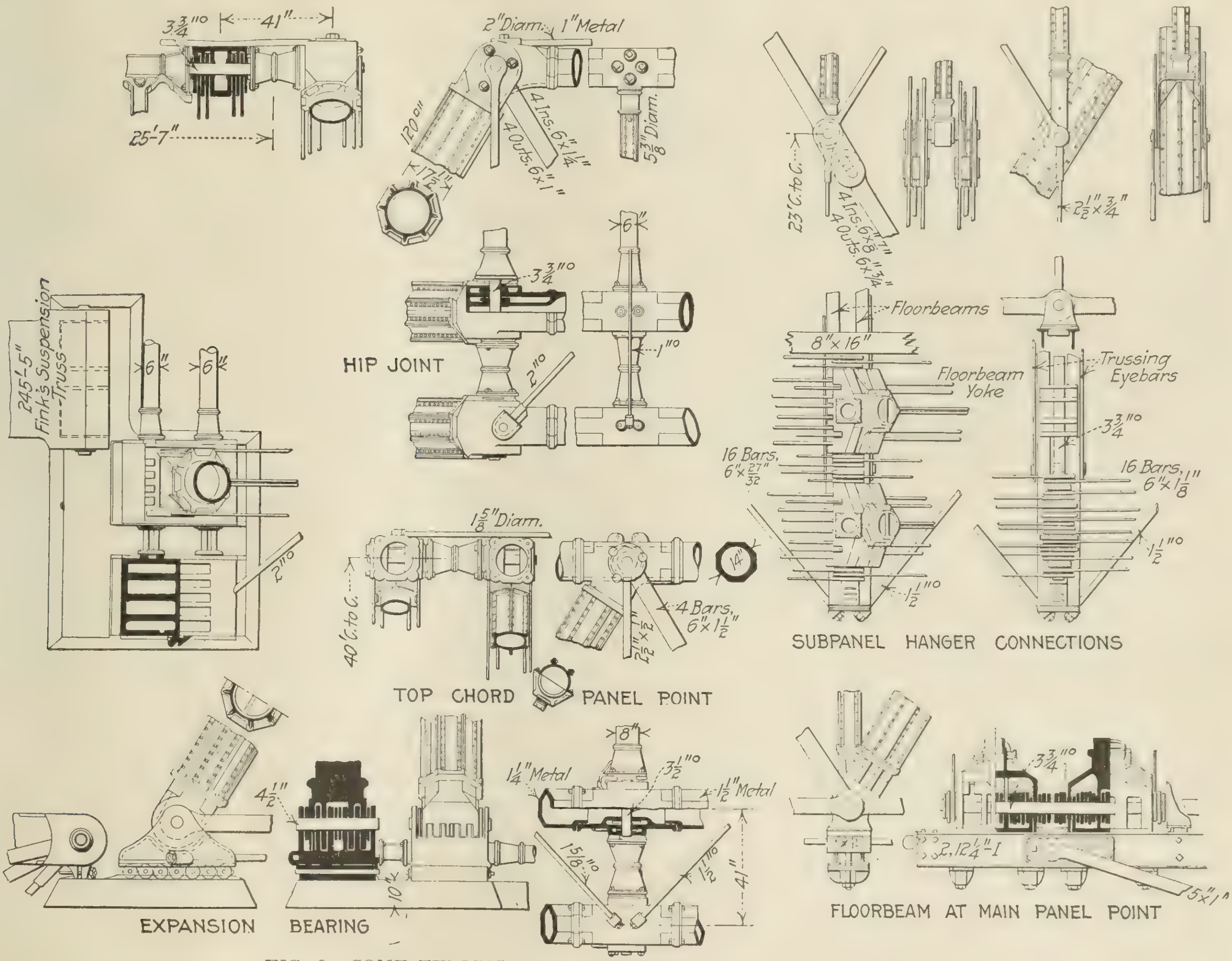


FIG. 8. SOME TYPICAL DETAILS OF THE LARGE THROUGH SPAN

A few figures of weight and cost may be of interest. For the entire bridge, 5261½ ft. long, the total iron weight is 8,869,000 lb., comprising the following items: Cast iron, 4,317,000 lb.; wrought iron, 3,245,000 lb.; column iron, 914,000 lb.; beam iron, 393,000 lb. In addition, the amount of timber in rail joists and crossties comprises 291,000 and 260,000 ft. b.m. The weights of four lengths of spans are as given in Table 1. The costs of the same span lengths are expressed in Table 2 and the construction cost of the whole bridge, $1,653,586.86, is itemized in Table 3. The original estimate was about 10% lower.

TABLE 1

Span Ft.	Span In.	Cast Iron	Wrought Iron	Column Iron	Beam Iron	Total
146	10½	101,453	63,904	6,320	..	171,677
242	.	213,000	180,000	37,200	.	430,000
368		480,953	350,928	228,473	60,694	1,121,048
396	2¾	570,585	478,022	280,920	75,938	1,405,465

TABLE 2

Span Ft.	Span In.	Ironwork	Framing and Raising Falsework	Raising Span
146	10½	$11,758	$450	$700
242	...	30,056	2,500	2,000
368	..	87,764	5,500	4,880
396	2¾	107,995	8,500	10,070

TABLE 3

Foundation	$615,702.52
Superstructure materials	703,067.40
Raising	114,041.75
Scaffolding	76,292.79
Tools and rigging	11,135.13
Painting	12,566.72
Engineering ($45,560.97) and other expenses	120,780.55

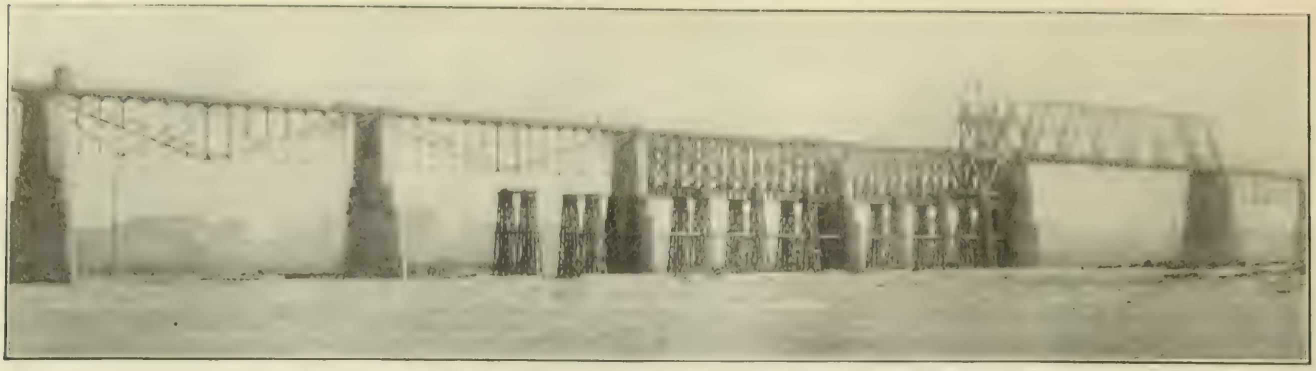


FIG. 9. PART OF THE LOUISVILLE BRIDGE AS IT APPEARS TODAY
View toward Louisville, showing Kentucky Channel span

places where flaking patches indicate that the protection is about at an end.

A most unusual proceeding was the painting of the inside of all Phœnix column members in the bridge, which was done a number of years ago. Some interior rusting of these columns had been noticed or was suspected, and the painting was decided on.

A force pump was used as the painting tool. A hose from the pump led to a perforated nozzle, which was inserted into the column through a hole at the top, lowered and raised up as the spraying proceeded. The paint was practically in brush condition. It sprayed perfectly. The pressure being high, it tended to wash the metal and took off a certain amount of rust, which was caught with the excess paint in a tub at the bottom. This was an iron oxide paint. It is still in good condition and has not lost color materially.

Bridge Shows Great Durability; Few Repairs

This bridge has existed for its entire period of life without any trouble with rivets or any replacement of rivets—an unusual experience with riveted work.

A peculiar feature of the rivets is that they were "beveled for half their length" to enable the rivet to fill the hole when upset.

All other elements of the structure have been almost as durable. There has been a slight amount of wear of the lateral rods where the two rods of a panel cross and rub on each other under the movement of the bridge. This and the loss of free movement at expansion rollers (of the through span; the deck spans slide on plate bearings) are virtually the only things that might be called wear in the bridge. There has been practically no pin wear so far as is observed in the pins already removed in the reconstruction. However, one main pin in a Fink span broke a couple of years ago and had to be replaced.

The pier masonry was repainted 18 years ago. The masonry is today in perfectly good condition and is used for the new bridge, the piers being cut down to suit.

The bridge was erected by the forces of the Louisville Bridge Co. (the owner). The ironwork was fabricated by the Louisville Bridge and Iron Co. The masonry contract was taken over by the company and carried through to completion by force account. Concerning the men in responsible charge of the work, Mr. Fink after commending F. W. Vaughan, Principal Assistant Engineer, says:

Mr. Vaughan was ably seconded by Mr. Edwin Thacher, assistant engineer in charge of the instrumental work, and Messrs. Patrick Flannery and M. J. O'Connor, in charge of the masonry construction, and Mr. Henry Bolla, in charge of the erection of the superstructure—a most difficult task well performed. The Louisville Bridge and Iron Co., contractors for the superstructure, have faithfully carried out the plans furnished them, and great credit is due to Mr. E. Benjamin, superintendent for that company, for the perfect execution of this work. The wrought iron was furnished to the Louisville Bridge and Iron Co. by the Ohio Falls Iron Works, and satisfactorily stood the test applied.

Should Not Engineering Teachers Know How To Teach?

By A. M. Shaw*

There is a general and insistent demand for an improvement in both the intellectual equipment and the ethical standards of the members of the engineering profession and particularly of those seeking admission to its ranks. A most encouraging feature of this agitation is that the demand for improvement springs from within the profession rather than from without.

The means advocated for securing the improvement desired cover a wide range, from the elimination of the inefficient and those lacking in enthusiasm for the work to the extension of the university courses in engineering from the usual four years to five or even six years. In addressing the freshman class of the University of Minnesota, Dean Shenehon said[1]:

Primarily, I want to congratulate you upon your choice of a profession and upon your chance in life. It is only a chance, an opportunity thus far . . . Undertaking work in the College of Engineering shows courage, for only strong men knowingly enter here where the portion is man's work. No mollycoddles may hope to prosper here. . . . I do not hesitate to tell you frankly at the outset that the task before you is not child's play nor boy's work; because if any of you does not thrill at the prospect of a stiff fight or a swift race, he is not of such stuff as engineers are made of —he is not in the right group.

In a recent address before the Engineers' Society of Western Pennsylvania,[2] Dr. J. A. L. Waddell said:

For 30 years the speaker has been preaching the necessity of five-year courses in civil engineering. As long ago as that there was a real need for more time in order to learn the fundamentals of the general science or art of engineering as then known and understood; but since then the amount of knowledge concerning all the numerous branches thereof has increased many fold, and, consequently, the truly necessary things that an engineering student must learn today in order to obtain a proper technical training cannot be taught him in a four-year course, even if there be 11 working months in the year—as there should be when fieldwork is properly covered.

In order that technical education may keep pace with engineering progress, one of two things must be done—either the engineering curricula in the universities and technical schools must be lengthened, or else they must be modi-

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[1]"Addresses to Engineering Students," published by Waddell & Harrington, Kansas City, Mo.

[2]"Proceedings" of the Society, Vol. 32, p. 467.

fied so as to cut out some of the more advanced courses, in order to permit more thorough instruction in the remaining ones and the addition of many culture studies, leaving those students who desire more complete technical education to obtain it in postgraduate engineering schools. In any case we need more postgraduate technical courses than are now available for the youth of the United States.

Most writers on the subject agree with Dr. Waddell that the time given to preparation must be increased, either by extending the initial course or by postgraduate work, it being generally conceded that in the better schools of the country no material addition to the amount of work covered during the four-year course may be undertaken.

The writer agrees with this position in its main features; but pending such a time as it may be possible to extend the preparation of the embryo engineer by lengthening his time in school, still further thought may be given to gaining greater efficiency of the student (and thereby increase his working capacity) within the present prescribed limit of four years.

It appears to the writer that this may best be done by improving his habits of study. No originality is claimed for this idea; in fact, it is emphasized in most of the writings on engineering education, though little has been written on how this may be done. There can be no doubt that if all students were to enter on their freshman year with well-established habits of study and a thorough knowledge of how to study and how to use to the best advantage every hour of the day, much work could be added to the four-year course without exceeding the capacity of the average student.

During the high-school period, students should be trained in the proper use of their time; but the haphazard methods of study, recreation and rest followed by the average university student would indicate that either proper habits were not acquired in their high-school days or that these habits were dropped on entering the university. To secure the greatest good, these correct habits should be established as early as practicable. This can only be done by making a close study of the individual students and by directing their efforts in minute detail during the first few months.

Is the ordinary college or university faculty equipped for such study and supervision? There is no disposition on the part of the writer to question the high aims, the ability nor the excellent work being done by the large majority of engineers who are engaged in teaching. Their devotion to the work which they have undertaken and the conscientious manner in which it is being performed command the respect of every engineer who is practicing in other branches of the profession.

This admiration does not necessarily blind one, however, to the shortcomings of the engineering faculties as ordinarily organized. Many of our schools employ the very best talent that can be obtained to place at the head of their engineering courses, and the other members of the faculty who are engaged in teaching the more advanced studies are among the best in their special lines; but how about the men who first come in contact with the freshman student? These instructors and assistant professors are often brilliant men who have been employed as the result of exceptional work as students, devotion to their alma mater or popularity with the student body—all excellent qualities, but none of them demonstrative of ability to train other minds or to impart information to them in the most efficient manner.

Engineers exercise the utmost care in writing specifications for materials of construction, but the same care is not used in writing specifications for those who are to direct the earlier efforts of our engineering students. Here is a fair sample of such specifications:

Wanted—A technical graduate for the position of instructor in the course of civil engineering in the X University. Applicants with one year or more experience will be given the preference. Salary, $80 per month.

The foregoing is not an exact quotation, but it would not require a very extensive search through the back files of any engineering journal to find something quite similar to it.

A teacher should not only possess the information that he desires to impart to others, but he should also be a master of the art (and it is an art) of presenting that information in such a manner that it may be acquired most readily by even a mediocre mind; or better yet, he should be able so to train that mind that it may gather information readily from all the available sources open to it.

In nearly every other line in which teaching of any sort is done, special attention is given to the training of those who are to teach. Directors and secretaries of the Young Men's Christian Association, public-school teachers and even Sunday-school teachers attend special training schools in which they are taught not only what to teach, but how to teach. In most states one must hold a certificate from an approved normal school or at least pass a satisfactory examination in pedagogy and allied subjects in order to teach in public schools of any grade. Those who teach engineering, however, learn the art of teaching by practical experiment on the student material under their charge.

The objection may be made that to insist on this additional preparation of young teachers of engineering would entail an additional expense that many of our schools are in no position to carry and would also keep out of the profession many deserving young men who, under the present plan, are able to obtain remunerative (?) employment immediately after graduation. Undoubtedly such a requirement would make necessary higher salaries for the lower-grade instructors and professors; but a readjustment of salaries would appear to be justified if better training of the student in the early part of his course could be thereby assured.

It hardly appears practicable for teachers of engineering subjects to secure in any of the existing state normal schools the special training advocated. The atmosphere would not be congenial, and the courses, as usually arranged, would not be readily adaptable to the needs of such teachers. The need might better be met by the establishment of a special course in some one or more of the larger engineering schools. A postgraduate course for teachers could be arranged, which could include a reasonable amount of special engineering studies. A graduate engineer should be able to add materially to his training along other lines at the same time that he takes special training for teaching.

Some of the wealthy friends of higher education might find in such a school a worthy object for an endowment of such proportions that a school could be established which would be able to give the best training possible to the young men who are to direct and advise the students of our engineering schools during the character and habit-forming period of their course.

Double-Track Work on a Busy Section of the Erie Railroad

SYNOPSIS—This improvement includes grade reduction and some relocation, and a new reinforced-concrete trestle across the Kankakee River. Excavation done by steam shovels. Material distributed mainly by dump-car trains, but on one section there was the unusual method of the steam shovels casting the material directly into place.

The 37 miles of double-tracking now in progress on the Erie R.R. between Lomax and Griffith, Ind. (30 miles east of Chicago), will give this road a double-track main line all the way between New York and Chicago (989 miles), except for about 20 miles of single track near Jamestown, N. Y. On this new double-track section the passing or relief sidings are made long enough for 100-car trains. It is of interest to note that from Griffith to Hammond (9 miles), the parallel single-track lines of the Erie R.R. and the Chesapeake & Ohio Ry. (on adjacent right-of-way) are operated by joint agreement as a double-track line. This saves the cost of double-tracking either of the two roads.

Although the country is flat, some grade reduction was included in the improvement, so that between Marion and Chicago (269 miles) the maximum grades will be 0.2% westbound and 0.3% eastbound, instead of 0.5% in each direction. The sharpest curves on the improved line are of 1° 50′. The flat country along the new double-track work was formerly swampy (the line traversing the great Kankakee marsh), but it has now been largely reclaimed by drainage works. There are only a few small towns along this portion of the line.

The profile was improved by raising fills in sags and lowering summit cuts, and the excavation approximately balanced the fill. Where small changes of grade were required in the existing track, these were introduced in ballasting, without disturbing the roadbed. All material for fill was obtained from borrow pits and cuts along the work. Oil pipe lines (pumping mains) 8, 10 and 12 in. in diameter are laid along the right-of-way. As a rule these were not affected by the borrow-pit excavation, but at some points it was necessary to shift them. The work includes about 1,200,000 yd. of excavation, 10,000 yd. of concrete for bridges and substructures and 350 tons of steel bridgework.

For 11 miles, a new double-track line was built with its center at 49.5 ft. from that of the original track, and the latter track was abandoned. This was done to get the desired grades without interfering with operated track. For 5 miles, the second track was built with its center line 52 ft. from that of the old track, and the latter was not changed. This gave the desired grades eastbound and westbound without disturbing the old track, which is to be the westbound track. At three points temporary detours were built, each about 1½ miles in length, for operation during construction. Fig. 1 shows the new second track built separately from the original line. It shows also one of the temporary detours or "run-around" lines built to carry traffic where the old single-track fill was being enlarged for double track.

This improvement work, which represents a total cost of about $2,100,000, was practically completed by the end of 1916. The general contract was let to the Robert Grace Construction Co., of Chicago, which has sublet only the 11-mile stretch of fill near Lomax (noted below). The steel bridge erection is being done by the railway company's forces. The construction is in charge of C. R. Hughes, District Engineer, with three Resident Engineers: M. W. Manz, W. A. Scott and F. E. Welsh. Maintenance of operated tracks is under F. D. Lakin, Division Engineer. Bridgework is under F. A. Howard, Engineer of Bridges. The entire work is under the direction of R. S. Parsons, Chief Engineer, and R. C. Falconer, Assistant Chief Engineer, of the Erie R.R.

Earthwork Methods

The new fills were made by dumping from temporary trestles. The trestles had 15-ft. spans with four-post bents in which all posts were battered, two meeting under each rail. The bents had round posts and squared caps and sills. The widening of old fills was done by side-dumping from the main track. Where the old fill was both raised and widened (and traffic diverted), the material dumped was thrown back under the construction track, raising the latter until the desired height was obtained.

All the excavation (for cuts and borrow pits) was done by steam shovels, and in most of the work the material was handled by standard-gage equipment, using 12-yd. dump-cars (with average load of 10 yd.). When operated over the main track, these cars were handled in long trains, in order to reduce interference with traffic. The trains consisted of about 40 cars with three locomotives, or 30 cars with two locomotives. A Jordan air-operated spreader-car was attached to the rear of the train. The cars were equipped for dumping by air, but as a rule they were dumped by means of a lever or pole, owing partly to lack of sufficient air pressure. Most of the locomotives were owned by the contractors and some were leased from the railway.

At the long and deep summit cut near Palmer (a new double-track cut) two 70- and 75-ton steam shovels with

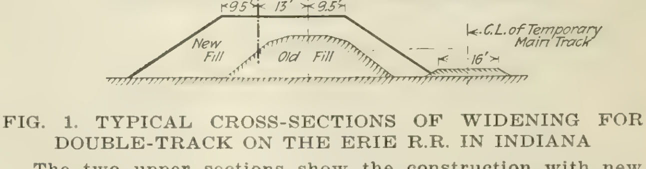

FIG. 1. TYPICAL CROSS-SECTIONS OF WIDENING FOR DOUBLE-TRACK ON THE ERIE R.R. IN INDIANA

The two upper sections show the construction with new fill and cut for the second track. The bottom section shows the enlargement of the old fill, with temporary runaround track

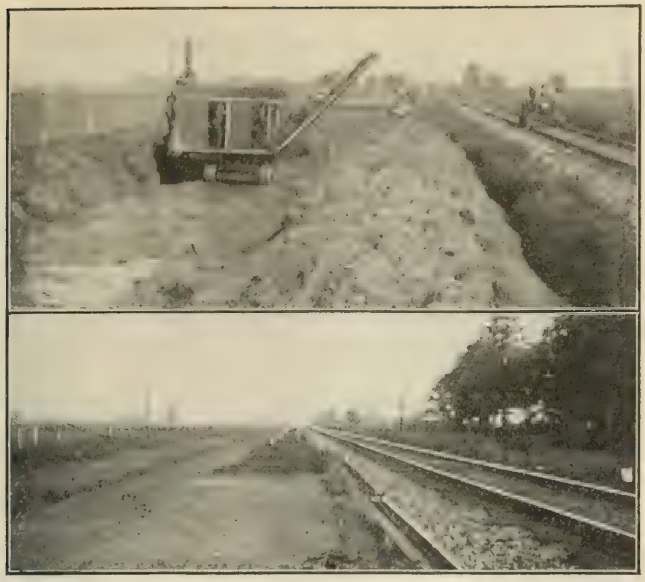

FIG. 2. WIDENING FILL BY DIRECT CASTING; ERIE R.R.

The upper view shows one of the revolving shovels casting material directly from the borrow pit to the fill. This is near Kouts, Ind. The lower view shows a stretch of the completed subgrade (looking west), with the old single track at the right and part of the new second track laid

2½-yd. buckets were used, working from opposite ends of the cut. One was served by narrow-gage equipment (36-in. gage) with trains of 4-yd. dump-cars and four-wheel dinkey locomotives. The other had standard-gage equipment. Both built new double-track fills by dumping from trestles. Small spreader-cars were used with the narrow-gage trains. There was a small amount of scraper work, mainly for the approaches at highway crossings. Much of the excavation was in tough, sticky clay. This did not dump well, and sometimes carried a 12-yd. car off its frames or trucks or carried a narrow-gage 4-yd. car bodily over the dump. The locomotive cranes employed for handling concrete material and driving piles were found useful in such emergencies. This material also caused occasional slides in the fill in wet weather.

The culverts were extended to the new slope lines regardless of slides. A sink-hole or deep pocket of wet, black, vegetable soil is crossed near Crown Point, Ind., and the old fill has to be raised periodically on account of the continual settlement. Although the new fill (against the old one) is light, its weight caused the ground to rise in a wave about 100 ft. from the track and in some places to a height of 15 ft. above the level of the top of the fill. At this point a drainage ditch 3 ft. wide on the bottom and 2 ft. deep, with slopes of 1½ : 1, was dug along the side of the right-of-way. This was excavated by a small revolving steam shovel with ½-yd. bucket, which was served by narrow-gage dump-cars and dinkeys.

The allowance for shrinkage of fill is 10% as a rule, but sometimes 15%. In widening fills the plan generally adopted was to make a sloping top, level with subgrade on the inner side and 10% higher at the outer side, as it was thought the settlement would be less over the slope of the old fill. A plan proposed by W. M. Dawley, Assistant Engineer, was to use a steam roller to roll the subgrade to take out the 10% excess height, and then to oil the surface so as to exclude frost and so prevent heaving.

The fill is mainly 6 to 30 ft. high, with a maximum height of 35 ft. The maximum depth of excavation for new cuts is 22 ft., but the lowering of grade in the summit cut will give a total depth of nearly 30 ft. for this cut. Where the fill is light, the surface of the old slope is not stripped or roughened to make a bond with the new material. In widening fills of over 10 ft., however, the old slope is required to be cleared and then formed in steps or benches. The width of roadbed on the old single-track fill is usually 19 ft. and is increased to 32 ft. for double track, with tracks spaced 13 ft. c. to c.

All new fills over 5 ft. in height were ballasted with slag or cinders, 12 in. deep under the ties. After a year's service, when settlement has ceased, the regular stone ballast will be laid upon this bed of sub-ballast. Cinders are preferred as they form a dense blanket, while mud will work up through the slag; but a sufficient supply of cinders was not available.

The rather unusual method of casting material directly from side borrow pits into the fill by steam shovels, thus eliminating all hauling, was employed for the first 11 miles west from Lomax. Here the new fill (deposited against the old single-track fill) averaged 5 to 7 ft. in height, and totaled about 130,000 cu.yd. of material. The subcontractor for this stretch of fill was F. J. Mann, of Wauwatosa, Wis., and he saw the possibility of doing the work cheaply in this way. A revolving shovel with ⅞-yd. bucket and 15-ft. boom did most of the work, and its highest record was 18,520 yd. in 25 shifts of 10 hr. each. The fill was leveled by means of teams with slip scrapers and road graders.

This fill was commenced in April, 1916, and it was estimated that with an average progress of 912 yd. per day it would be completed in August, before the fall period of bad weather. The progress, however, did not come up to the requirements, and the engineers ordered a second machine installed, as with wet weather this method could not be operated. This would have rendered unavailable the borrow-pit sites already purchased by the company along the right-of-way, and it would have been necessary to haul in material, which would have added to the cost and involved occupation of the main track by work trains. The second machine was of the same type and size, but with a boom only 12 ft. long. In this way the work was completed by Oct. 15, in time to escape a period of heavy rains. Fig. 2 shows this fill in progress.

Bridges and Concrete Trestles

The most important structures are two reinforced-concrete trestles crossing the two channels of the Kankakee River. These are 322 and 162 ft. long, separated by 1100 ft. of fill, which replaces an old pile trestle. The bents are of Massey precast concrete piles, 25 ft. long, spaced 30 in. c. to c., and the bents are 16 ft. c. to c. The top stratum of soil is sand. Below this is a mixture of sand, gravel and clay, which makes very hard driving and in which the water jet is of little or no use. The piles were driven by a Vulcan 5-ton steam hammer. At first a lighter Vulcan hammer was used, but this was not powerful enough for the work, and it was necessary to cut the heads of some piles. For this the concrete was broken with a sledge and a chisel, and the bars were cut with a hacksaw. With the heavy ham-

mer the piles are driven to the full depth and no cutting is necessary.

Each bent has a cap cast upon it, and the concrete deck is cast in place upon the caps. At intervals, where an expansion joint occurs in the deck, there is a double bent with wide cap. The fixed end of one slab is secured to the cap by dowel rods, while the free end of the other rests on top of the cap. All the caps have very heavy steel reinforcement. The abutments are so made as to serve as piers in case it should be necessary to give increased waterway by additional spans.

The deck is a flat slab with curb walls to retain the ballast, and is built in lengths of 64 to 80 ft., separated by expansion joints. This deck really consists of 16-ft. I-beam spans embedded in concrete, each span having a series of I-beams grouped under each rail, with old rails laid outside of the beams. There are no bars, but sheets of welded woven-wire fabric are placed under the I-beams.

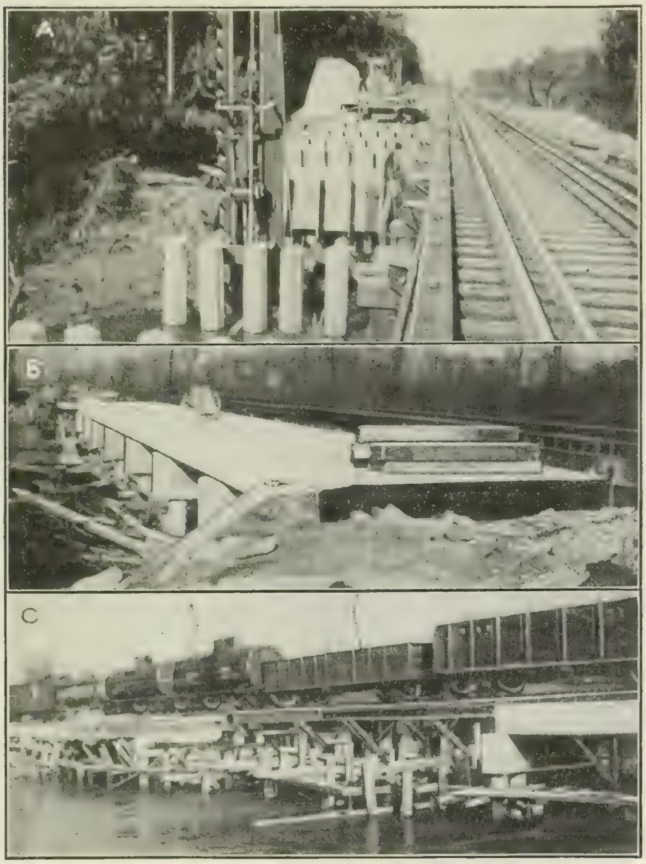

FIG. 3. REINFORCED-CONCRETE TRESTLE OVER THE KANKAKEE RIVER; ERIE R.R.

A—Driving concrete piles for new trestle alongside old timber trestle. B—Section of completed deck. C—New concrete trestle being built alongside old timber trestle. The open space is for a girder span at center of channel

In each one-track span there are four 1½-in. drainage holes, and in order to shed water from the central longitudinal joint a small ridge is built along the inner edge. An unusual feature is the use of 1½-in. galvanized pipe sleeves in the drainage holes, with their lower ends projecting 2 in. below the concrete. Their purpose is to prevent damage to the concrete by the brine which drips from refrigerator cars and may be washed to the drainholes.

This double-track trestle was built in two longitudinal sections. The first of these was alongside the original track and when completed traffic was diverted to it, while the old line was torn up and the second half of the trestle built. The caps are built with a halved joint at the middle, so as to connect the two sections of the trestle and to distribute the load over the piles.

At the middle of the trestle over the main channel of the river there is an opening 38 ft. wide to pass dredges and drift. This has concrete piers carrying a plate-girder open-floor deck span.

There are few other important structures. Culverts are mainly of concrete with I-beams and rails embedded in the roof. Existing cast-iron pipe culverts (of ordinary water pipe) are extended to the length required for the widened fill. Drainage ditches are crossed by open-floor plate-girder decks or through spans of 24 to 50 ft., generally with three girders. The law requires that for such crossings the railways must install bridges that can be removed to allow the passage of dredges.

Bridges over highways have plate-girder spans with a solid steel deck waterproofed with a course of brick laid in an asphaltic composition. Some highway bridges over the railway are of interest in having concrete abutments, bents and slab side spans (over the slopes of the cut), with plate-girder spans over the tracks. These steel spans have plank floors.

The concrete is made with stone in preference to gravel and for this a hard local limestone is used. Gravel concrete is used in some cases, however. Wood forms are employed. Exposed surfaces are well rubbed with cement bricks and water. In all concrete structures the date (year) of construction is marked in recessed figures, and the contractor is required to place a metal nameplate or label. This is a small oval plate of bronze, bearing the contractor's name and the date of construction.

The concreting plant at the Kankakee River bridge has a set of stationary bins from which material is wheeled to a drum mixer of 15 cu.ft. capacity, which is kept near the work. From this the concrete is distributed by wheeled carts. For other work a portable concreting outfit is used. This consists of a flat-car having at one end a low hopper with spout to the boot of an inclined bucket elevator, which discharges into an overhead bin for aggregate. A chute from this delivers the material to a ½-yd. mixer at the other end of the car. The aggregate is delivered from cars to the hopper by means of a locomotive crane operating a grab bucket.

Locomotive cranes are used for piledriving, with swinging leads suspended from the head of the boom, and also for pulling the sheetpiling of cofferdams. Steel sheeting was used at the piers for the steel spans of the Kankakee River bridge, and where this was too twisted or jammed to be pulled out it was cut away by oxyacetylene cutting torches.

Track, Work Trains, Etc.

Ballasting and trackwork was done by the general contractor on a force-account basis. Steel bridge erection was done by the bridge gangs of the railway's construction department. The new tracks are laid with 100-lb. rails of the A. R. A. (A-type) section, on 8½-ft. creosoted red-oak ties, with broken-stone ballast 12 in. deep under the ties. Sub-ballast is used on new fills, as noted above. Tieplates are laid on all ties on curves of over 1½°. It is of interest to note that the splice bars are

oiled, as a protection against corrosion due to brine dripping from refrigerator cars.

The stone ballast used on this road is unusually coarse, the specified size being from 1 to 2½ in. On this work the stone is distributed from steel hopper-bottom ore-cars with transverse hopper doors. These were handled in trains of 30 cars, moving at very low speed. Only one car was unloaded at a time, two or three ties being laid across the rails in front of its rear truck so as to plow off the stone as it flowed from the car. Very little trouble was experienced in leveling the material in this way (although it is not generally regarded with approval) and derailments due to it were of rare occurrence.

Progress records are kept by a series of profiles or diagrams showing the grading, concreting, dressing of roadbed, ballasting, tracklaying, etc., and showing also the supply of rails, ties and other material. These are graduated horizontally for days and vertically for cubic yards, lineal feet or other measurement. A straight line drawn in advance upon the diagram shows the progress required for the completion of the work within the desired time, and the plotted progress record shows how nearly the work approximated to the requirement. In this way there is a graphic record of the actual and relative progress.

The traffic on this part of the line is heavy, the daily number of trains in both directions averaging 40 (including passenger and freight regular and extra trains); therefore, work trains operating on main track cannot make much progress. The main track is occupied as little as possible for construction work, but has to be used by the dump-car trains in the first widening of fills by side dumping. Construction tracks are then laid as soon as the increased width permits. The movements of the work trains on the main track are controlled by the telegraph operators, working under instructions from the dispatcher.

Exploring a Deep Well by Gas Seal at Saratoga Springs, N. Y.*

By C. G. Anthony†

In 1885 the well now known as Hathorn No. 1 was drilled at Saratoga, N. Y. It is a 3-in. diamond drill bore, 1006 ft. deep. In 1911, when the State of New York took possession of the Saratoga springs through condemnation proceedings, this well was not flowing. As this water, with the exception of the Congress water, was the most famous of all Saratoga's mineral waters, the state officials deemed it advisable to do everything possible to restore the water to the public. An extensive survey was made of the bore, and the completed log of this well is only one of many interesting and peculiar problems to be found in this valley of hydraulic wonders.

A 1¼-in. pipe was placed in the 3-in. diamond drill, with two rubber seals on the pipe at the bottom and 5 ft. apart. The bottom of the pipe was plugged, and the section of pipe between the seals was perforated so that the water would pass into the 1¼-in. pipe between the seals. The seals were slightly larger than the 3-in. diamond bore. By adding lengths of 1¼-in. pipe and pushing the seals down, the seals could be placed at any point in the well; and by means of a pump, water was taken from various points in the well and analyzed. This survey gave the following data:

0 to 155	Dry hole
155 to 161	Scant supply of mineral water
161 to 205	Dry hole
205 to 211	Light vein of mineral water
211 to 242	Dry hole
242 to 254	Scant supply of mineral water
254 to 266	Dry
266 to 283	Pure soft water (hardness, 100)
283 to 317	Dry hole
317 to 329	Scant suppiy of mineral water
329 to 346	Dry hole
346 to 384	Very light vein mineral water
384 to 405	Strong spouting vein (spouted 35 ft in air)
405 to 411	Dry hole
411 to 414	Strong spouting vein (spouted 35 ft in air)
414 to 423	Dry hole
423 to 426	Scant supply of mineral water
426 to 458	Dry hole
458 to 482	Strong vein of mineral water
482 to 485	Dry hole
485 to 498	Large supply of soft sweet water (hardness, 110)
498 to 510	Dry hole
510 to 540	Fair vein of mineral water
540 to 567	Dry hole
567 to 573	Fair supply of mineral water
573 to 585	Dry hole
585 to 595	Good vein
595 to 600	Dry hole
600 to 606	Fair supply of mineral water
606 to 622	Dry hole
622 to 629	Fair supply of mineral water
629 to 912	Dry hole
912 to 919	Fair vein of mineral water
919 to 928	Dry hole
928 to 935	Strong spouting vein of mineral water (spouted 40 ft high)
935 to 1,006	Dry hole

By separating the veins of mineral water by rubber seals and confining the large quantities of CO_2 gas that passed into the well with the veins of mineral water, three veins were found that contained enough gas to make the mineral water flow with a sputtering pulsating motion high into the air. Once started, the well would continue to flow until it was stopped by means of a water seal.

The water seal is a very curious phenomenon connected with the natural flowing wells that have been drilled and cased. If even in the strongest springs at Saratoga the tops of the casing be covered tightly so as to prevent the flow of water and gas, and if the tight cover be maintained for one or two minutes, the well will not resume its flow on removing the obstruction. If it be artificially started with a pump, it will flow as strongly as ever. The phenomenon is called the water seal, since the spring is, as it were, sealed off by water.

All the veins marked mineral water showed on analyses large quantities of soda, magnesia, lime, potassium, chlorine and CO_2 gas and small quantities of lithia, strontia, baryta, bromine, iodine, alumina, silica, radium and organic matters.

Of the most interest are the two veins of fresh water flowing into the well, one vein between 226 and 283 ft., the other between 485 and 498 ft. Mineral water was obtained above and below these veins. None of the rare elements found in the mineral water were found in these two veins. Where does this water come from?

The driller reported the drill passing through 62 ft. of drift; 713 ft. of dolomitic limestone; 231 ft. of Potsdam sandstone; total, 1006 ft.

*A previous article by the writer ("Engineering News," Jan. 18, 1917) explained some of the conditions surrounding the mineral wells, or "springs," at Saratoga. It may be stated here, by way of further explanation, that mineral waters at Saratoga are derived from an artesian horizon, but the water is not under sufficient pressure to cause it to flow at the surface; that these waters contain large quantities of carbon dioxide gas in solution, ranging from 1 to 2 volumes of gas at atmospheric pressure per volume of water, to 12 or 14 volumes of gas; that the quantity of gas which the water can hold in solution increases as the depth or pressure increases. At atmospheric pressure a volume of water will retain 1 volume of gas. Water derived from a depth and containing several volumes of gas, if brought to the surface, will release the gas that it contains in excess of 1 volume, as it approaches the surface. In flowing upward through the casing of a well the gas released acts as an air lift and practically all the flowing wells, or so-called springs, at Saratoga flow by virtue of the pressure of released gas and not by hydrostatic pressure.

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Steel Sheetpile Bulkhead Driving Affords New Experience to Designer

By Herbert D. Mendenhall*

SYNOPSIS—Some of the unexpected difficulties found in driving a sheetpile bulkhead wall of unique design at Jacksonville, Fla.

Some new thrills in the driving of steel sheetpiling developed during the course of construction of the reinforced-concrete and steel retaining bulkhead for the Commodores Point Terminal Co., at Jacksonville, Fla. This project was described in a general way by the writer in *Engineering News*, Oct. 21, 1915, p. 772. At that time all was well, for the designs were complete, they fitted perfectly the conditions as they were then known to be, and in the optimistic eye of the designer all sheetpiling interlocked perfectly, matched true to dimension from top to bottom, all wood guide piles centered exactly and did not get out in the way of the other materials to be placed—in fact, "all was joy in Mudville," for mighty Casey had not struck out!

Soon after that writing the game began, with a bellicose contractor heading one team and an obdurate engineer the other, with the old umpire Experience vainly trying to make a good showing for the onlooking fans, prominent among whom were a Board of Directors and a Criticizing Public.

It may be recalled that the design of the bulkhead embodied a unique combination of steel sheetpiling, I-beams and concrete. So far as casual investigation shows, a similar combination has never before been used in this class of work. It consists essentially of a row of interlocked steel sheetpiling of the Wemlinger heavy sections driven approximately 1 ft. into rock, stiffened every alternate pile or on 37-in. centers with 12-in. standard steel I-beams interlocked with the sheetpiling, and driven to a minimum depth of 34 ft. below the plane of mean low tide and in every instance to a minimum penetration of 3 ft. into rock. A diagram of the combination is herewith reproduced in Fig. 1, and a typical section made up of short lengths of the steel piling and I-beams interlocked and set up is shown in Fig. 2. The anchorage or tie-back system consists of a horizontal wale between successive I-beams tied back with rods and turnbuckles to a braced pile anchor system. The wales are built up of two standard 4-in. channels, each 2 ft. 11 in. long, bolted back to back with $\frac{3}{4}$x$2\frac{1}{2}$-in. machine bolts and separated by $1\frac{1}{2}$-in. gas-pipe separators $1\frac{1}{2}$ in. long on each bolt. At midpoint of this wale combination and on the centerline of the intermediate sheetpile a 1-in. rod, upset each end to $1\frac{3}{8}$ in., ties the wall back to the anchor piles. Fig. 3 shows the wale combination in actual operation with the attendant irregularities. The point to this story is enveloped in the experiences encountered in driving the sheetpiling.

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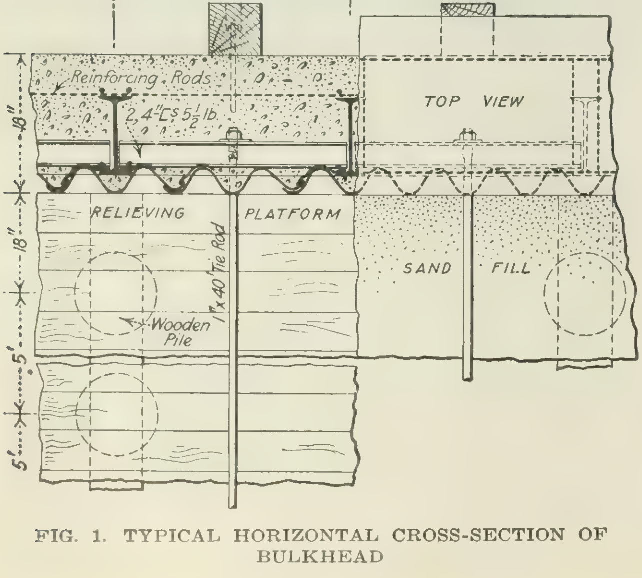

FIG. 1. TYPICAL HORIZONTAL CROSS-SECTION OF BULKHEAD

The piling interlock is fabricated from a $\frac{1}{2}$x9-in pressed-steel clip riveted to the sheetpiling every 5 ft. in such a manner as to engage the edge of the preceding pile. The piling ranged in length from $24\frac{1}{2}$ to 37 ft., except where spliced to get greater penetration, as will be described.

FIG. 2. MODEL SECTION OF STEEL BULKHEAD ASSEMBLED

It was the roseate intention of the optimist—that is, the designing engineer—to drive the piles so that the clips of each succeeding one would conveniently and comfortably interlock over the edge of the one already driven, insuring a perfect joint along the entire length of all the piles. But, alas! "The best laid schemes o' mice an' men gang aft a-gley," and the steel company had put the clips on backward! Situation: Ten carloads of steel piling on hand and distributed, an ill-tempered contractor with full equipment just "r'aring" to start, a dredge waiting to begin pumping behind the bulkhead, and a frantic engineer responsible for the progress of the work tearing his hair to get things moving. Solution: Start operations anyway, reversing the order of things by driving the piling *into* the clips—dangerous, but expedient! Meantime a hot wire flashed to steel company to change sides with clips, and quick answer received that "on account of the war" it would be impossible to make any changes, or words of like import. Very well! By setting up and interlocking a long wall

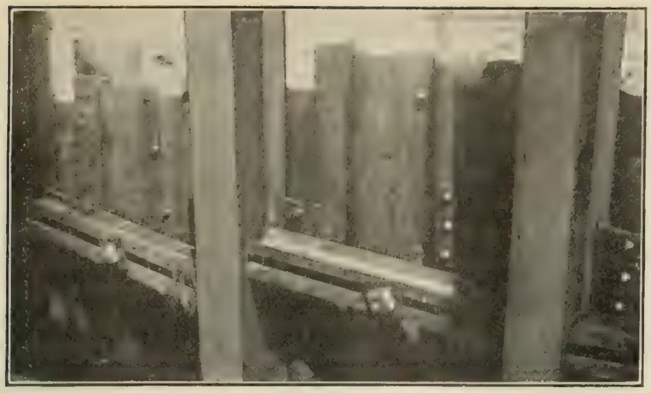

FIG. 3. ANCHOR WALES IN PLACE

of the piling before beginning to drive, everything should go safely enough. Method started and goes beautifully until driving begins, when discovery is made that the interlocking corrugations lap so far that the steam-hammer follower cannot engage the center of a pile without hitting the corner of the adjacent ones, and attempting to drive with the hammer near a corner deforms the piles too much. Hence, the only way left is to drive each pile separately before interlocking the next one.

This method did very well, and serenity once again pervaded the atmosphere. Resourceful engineer to think of and permit such a simple and successful expedient!

At 25 ft. from the point of beginning there commences a curve of 24-ft. radius, extending through 90°. According to the original scheme of driving, this curve could have been easily negotiated, as the direction of curvature would have loosened rather than tightened the piling in the clips. But for reasons already stated, the original procedure could not be followed, and so once again trouble stalked forth on the land! Fearing possible complications of the kind, the engineer left instructions at the close of the first day before starting on the curve to set up a number of piling ahead to test out the possibility of curvature before beginning to drive. Satisfied that this procedure would be carried out, said engineer sleeps peacefully that night, eats heartily next morning, only to be ruthlessly disturbed near end of breakfast by a wild telephone call from inspector stating that the contractor is refusing to carry out instructions to the letter because of a misunderstanding between the foreman and the inspector and that the piling is being driven regardless of consequences. By the time the engineer arrives on the job, six piles have been driven on the curve, the bottom of each pile extending farther out from the line of the bulkhead than its predecessor, due to lack of sufficient flexibility in the interlock to take the curve, a general mess resulting. The contractor, on being held up, contritely agrees to pull all wrongly driven piles and redrive them according to instructions. Very nice of contractor! But unfortunately, engineer knows that the driving was very hard and that rigging to pull the piles will cause a delay of several days—and an ominous dredge waiting to start! Accordingly, it is decided to drive the next pile out of the interlock and plumb to line, and to close the resulting gap at the toe by driving an additional pile behind.

Thence to the completion of the curve each alternate pile was driven out of the interlock in order to follow the sharp convexity. This procedure worked out with reasonable success, only two or three slight leaks resulting on the entire curve. Later, lengths of a lighter section of steel piling were driven inside the bulkhead opposite the cracks, successfully stopping the leaks.

After leaving the curve, driving proceeded nicely for about 300 ft. Then it became evident that there was a decided tendency for the tops of the piling to lean forward, necessitating the continuous pulling of them back with double blocks and tackle. This crawling ahead was caused doubtless by the slight deflection of the toe of the pile, either in or out, when it encountered the rock or even while being driven, and by the crowding of the piling back into the interlock—both of which actions would tend to shorten the line at the bottom of the piles, while the pulling of the piling against the guide wale would unfailingly keep the top line of the piling moving ahead to specified spacing. The continual pulling backward of the tops of the piles unavoidably caused a wavy appearance in the line of piling, and at a later date, when the wales and tie-back system were put on, necessitated the cutting of a number of the top clips in order to prevent a sharp kink from occurring at intervals. The shortening of line resulting from this procedure amounted to about 2 ft. in every 100 ft. of wall.

When the crowding forward had progressed to the point of becoming alarming, a joint conference of every-

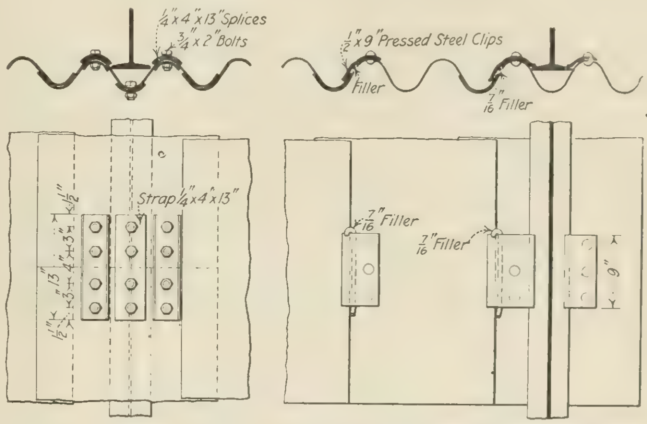

FIG. 4. SHEETPILING SPLICE AND CLIPS AND BOTTOM FILLERS

body who had an idea was called. It developed that in driving similar piling at a previous time, but with the interlocking clips located as they should have been, the tendency was always for the tops to drag back instead of crawl forward, necessitating a continuous pulling *forward* with the blocks and tackle. This was the consummation devoutly to be wished, as it would eliminate kinks and incidentally gain all slack in the interlocks. Accordingly, it was decided to change ends with the piling and drive them in the manner originally intended. This necessitated purchasing an oxyacetylene outfit and cutting a handling hole in the opposite end of each pile thereafter. To further keep the toe forced ahead as far as possible, a $\frac{7}{16}$-in. filler rod was inserted in each bottom clip, as shown in Fig. 4, thus gaining about ½ in. per pile. Still further gains were attempted by flattening out the forward edge of each pile for a distance of about 10 ft. from the bottom.

These various subterfuges resulted in reducing the loss per 100 ft. from about 24 in. to about 6 in. The total loss for the entire 5164 ft. of bulkhead was about 66 ft., or slightly over 1%.

As the level of the surface of the rock varied rapidly, necessitating different lengths of the sheetpiling, extra piling had to be inserted at frequent intervals to make up the loss in length of line and keep the proper lengths of piling located at proper points. Station distances were accurately marked on the guide wale, and the theoretical station number of each pile with its length was entered in an inspector's book. By means of this book and the marked station distances, the inspector could keep accurate account of the loss of length and insert the necessary extras when needed. And here developed another problem. Extra piling for fillers had to be ordered, but of necessity could not be delivered as needed. In fact, the accommodating steel company advised that it could not vary the order of shipping in any detail and would have to ship the extra pieces *last!*

But engineers, like their proverbial prototype, when crushed to earth will rise again; and once again a difficulty was overcome. Simply determine the length of piling that occurs most frequently and order all the extra pieces that length. Then put the fillers at the points where this length of piling is called for. Thus the shortage accumulated in one length only and was filled before the end came.

After meeting and solving the difficulty of making the feet keep up with the head, came the revelation that the lengths of piling were not coming in proper order, but in bunches of the same length. Result: Gaps, at times, of as much as 1000 ft., for which there would be no suitable lengths. Delays and most grievous complaints from contractors! Timid requests to angelic steel company that it, please, sir, send the steel in the order specified and agreed on! Curt response that they could not do it that way, as they had divided the order up into sections and proposed to fill each section indiscriminately as to continuity—but apparently "back end to." Inasmuch as we were only Americans, we should have been glad to get steel at all, at all.

As the piling began to accumulate and short gaps yet remained, it became necessary to substitute shorter or longer lengths for those called for at certain stations—trusting to luck that all would work out right in the end. As the rock borings to determine the profile of bottom had been made at 25-ft. intervals, naturally intermediate irregularities occurred frequently. By having the inspector watch the piling very closely, advantage could be taken of these irregularities and it was sometimes possible to put in shorter lengths of piling than those specified.

The character of the driving varied through wide ranges on the several parts of the work, with stiff mud for full depth at one point, quicksand for full depth at others, alternate strata of sand and clay at still others, and for one stretch of about 1500 ft. practically nothing was encountered before striking the rock. It was noticed that the tendency of the piling to crowd back into the clips at the bottom occurred mostly in the deep sand driving. Where nothing but rock was encountered and there was correspondingly very little driving, the piling even tended to lean backward at the top, making possible a pulling-ahead process and permitting a gain rather than a loss over theoretical spacing. But unfortunately, the hard driving predominated, and so an ultimate loss was sustained, as already mentioned.

In the beginning driving was attempted with a steam hammer only. A No. 1 Vulcan hammer with McDermott base and cast-steel driving cap was used. But as the sand became deeper and the friction resistance increased, it became necessary to install a water jet to relieve the friction. After installing the jet, little more difficulty was experienced in getting the piling down.

Along one stretch of about 730 ft. of the bulkhead the rock bottom dipped to a depth that could not be reached with the I-beams. It was decided to gain the necessary foot stability by driving the sheetpiling deeper, into a stratum of clay that lay from 4 to 12 ft. below the extreme depth of the originally designed piling.

At this juncture effort was made to get longer lengths of piling substituted for tl. ones ordered. The steel company could not consider such an accommodating act, not even at an advanced price for the substitute pieces. So it was decided to splice the short lengths. The type of splice used is shown in Fig. 4 and consisted essentially in bolting five 4x13x¼-in. straps in the corrugations as shown and hoping that they would be rigid enough to stand the necessary driving. As a matter of fact, they did drive very nicely on first appearance. The trouble did not develop until some time later, after the dredge had started pumping material in at that point, when it was found that the splices under the heavy driving had frequently offset just enough to let the clips on the succeeding pile pass behind the lower section and leave a continuous opening about 1 in. in width, from the bottom of the top splice-piece to the bottom of the wall. This defect permitted 1000 cu.yd. of material to pass through the bulkhead before it was discovered. These cracks were later stopped by driving extra piling behind the wall covering the cracks and in addition forcing calking material into the cracks from the outside. A diving apparatus was employed.

An ingenious method of maintaining a straight line against the intrusions of obstacles on the bottom was developed during the course of the driving. It was found that not infrequently the toe of the piling would encounter a peak of rock, a sunken log or other obstruction and would be deflected in or out from a straight line. This deflection would obviously shorten the bottom length of the line of piling and accentuate the dreaded crowding ahead of the tops. After several such obstructions had been encountered, it was discovered that the trouble could be overcome by ceasing to drive a pile the moment it showed signs of deflecting, pulling it back up until it stood plumb, and interlocking and driving several piles ahead of it and past the obstruction. This gave a strong guide for the partly driven pile, and it could then usually be driven on to grade without any shortening of the bottom line.

Advice for Such Work as This

1. In a long wall provide for some means of breaking the wall to permit straightening up of the piling. Tapered piling or "dutchmen" would answer the same purpose.

2. Provide in the specifications for setting up of the wall several piles ahead of the driving. Special followers may have to be provided to accomplish this.

3. Do not figure too closely the space a pile will cover, but make generous allowance.

4. Do not introduce too great refinement in ordering varying lengths of piling where the toe stratum varies in elevation. It only causes confusion in shipping and distributing, and may cause bad feeling toward the steel company.

5. Order the steel a sufficient time ahead of the need for it to forestall delays due to unexpected wars.

6. Provide an oxyacetylene torch and a diving helmet.

7. Do not get despondent, for others have had trouble too.

New Methods in Tunneling in Variable Soft Ground

By L. G. Warren*

SYNOPSIS—Radically new features in pneumatic tunneling were brought forth by the difficulties in the Milwaukee Shore Tunnel: Cutting hard clay and hardpan with air chisels; clay plastering of the timber sets and sheathing to hold the air; draining the face and bench by well points driven ahead. The operations are described in detail.

The Shore tunnel of the Linwood Ave. Intake System at Milwaukee encountered unusual difficulties due to variable soft ground and serious water conditions. The contractor was forced to devise original methods of dealing with the different conditions. Compressed air has been used throughout in all of the four headings except for a short starting period in the headings from Shaft 2. The pneumatic method alone, however, did not prove adequate to cope with the range of face conditions, from running sand to hardpan and shale, the total range sometimes appearing in a single face.

FIG. 1. CLAY-PLASTERED HEADING IN POROUS GROUND, MILWAUKEE SHORE TUNNEL

Soil above spring line is open sand and gravel, allowing escape of compressed air. Bench in stiff red clay is being excavated by air chisel. The entire surface of the timbering and breasting is being plastered with clay to hold the air; laborer in background is claying up

The tunnel is 9 ft. in diameter with 12-in. shell of plain concrete, making an excavation diameter of 11 ft. It will be 5644 ft. long. Operations are conducted from two shafts, of which the northerly is called No. 1 and the southerly No. 2. The success of the methods, both of construction and supervision, was assured on July 22, 1916, by the junction of headings between Shafts 1 and 2.

The tunnel is to serve as a connecting conduit between the Linwood Ave. intake or lake tunnel and the North Point pumping station. A sketch map of the intake system and a description of the work on the intake tunnel (a 12-ft. tunnel under the lake, 4000 ft. long) may be found in *Engineering News,* June 18, 1914, p. 1364. This tunnel is now being extended into the lake a distance of 2500 ft. In the future a 9-ft. concrete tunnel will be driven from the shore shaft of the lake tunnel directly west to a new pumping station about 7000 ft. west on Linwood Ave.

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Conditions Encountered in the Tunneling

The advisability of employing the compressed-air method has been continuously substantiated as the drifts advanced. The drifts from Shaft 2 were started in normal air, but each met water-bearing gravel after progressing a little over 100 ft. Work from Shaft 2 started north and south on Sept. 13 and Sept. 17, 1915, respectively. Compressed air had to be applied in the early part of November. The headings from Shaft 1 started on Nov. 5. At this time, the necessity for the use of compressed air was already demonstrated, and, the shaft being 45 ft. off the line of the tunnel, a joint air lock for both headings was placed in the connecting drift.

The soil encountered has been water-bearing sand and gravel, deposits of a mixture of gravel with sand and lumps of shale and boulders, deposits of quicksand, decomposed shale, ledge shale, hardpan and boulders. The soil conditions have changed within a comparatively short distance from sedimentary to glacial deposits and vice versa. As high as nine distinctly different strata have been encountered in the same face within a vertical height of 11 ft. In one of the worst cases the face showed in order, from top to bottom, red clay, fine sand, washed gravel, coarse sand, decomposed shale, ledge shale, hardpan and boulders. The decomposed shale was met in a deposit 6 ft. thick later on in the mining; it was black, very compact, without stratification lines and was the result, probably, of a severe grinding action of natural forces, followed by enormous pressure. In every case, shale in ledge form lay beneath the decomposed shale.

The soil cover over the tunnel ranges from 19 to 98 ft. The tunnel passes partly under the lake beach and

FIG. 2. AIR BLOW ALONG LAKE SHORE FROM HEADING 300 FT. AWAY

North heading of shaft 1. Danger of blowout to lake set a limit on the air pressure that can be used in the tunnel

partly under the high bluff of Lake Park. The head of water has in general corresponded to lake level, being about 20 ft., but in several cases the head has been considerably above that due to the lake level.

A notable example occurred in the south drift from Shaft 2 at Station 9 + 81, following a collapse of the excavation roof, which resulted in an inrush of water amounting to about 200 gal. per min. At the time of the collapse the air pressure was 11 lb. It was then raised to 14½ lb., which held back the inflow for a time, but in a few hours proved inadequate. Successively 17, 18, 22, 23, 24 and finally 27 lb. pressure was applied with the same result. The tunnel invert was 27½ ft. below lake, equal to about 12 lb. hydrostatic pressure. It was in this experience that the use of well points for draining the face was suggested and tried, with success, as will be described later on.

A limit to the amount of air pressure that could be used lay in the nearness of the lake shore, particularly

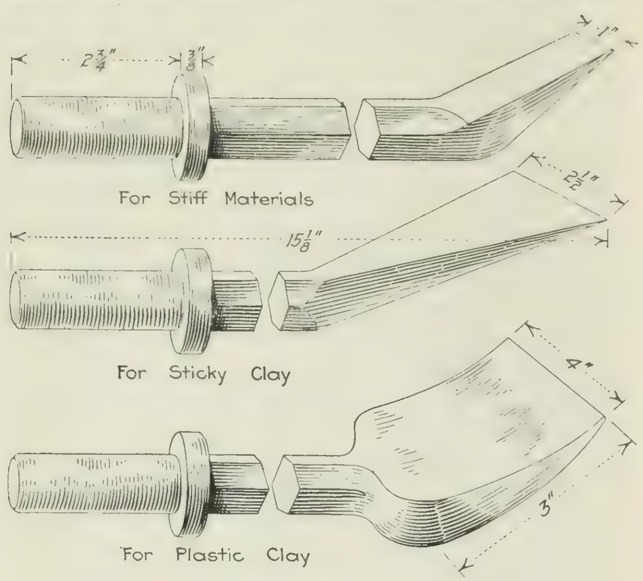


FIG. 3. AIR-CHISEL BITS FOR HARDPAN AND CLAY

The narrow chisel is successful in hardpan but failed in sticky clay. The wide bits handle sticky and plastic clay effectively. The hammer used has 1½-in. bore and 3½-in. stroke

in case of the north heading from Shaft 2. Great care has been used in this heading to have the air pressure exceed only slightly the hydrostatic lake-level pressure. Distinct blowing through of air was observed in the water close along the shore line on many occasions (see Fig. 2). It was felt that the danger of blowing a large opening through the sand to the lake existed, in case of any material rise in air pressure in the heading.

Slow Progress in Hardpan; Pneumatic Chisels Prove the Solution

Ordinary pick-and-shovel mining was started in all headings. The material that gave most trouble in the early stages was hardpan, with pockets of gravel, and stiff, stony red clay. On account of the slow progress with hand picks, blasting was tried, using 40% dynamite. This materially increased the speed of mining per shift, but any gain was offset by the delays caused by several roof falls, due to the blasting. After less than 300 ft. progress in one heading and after only 29 lin.ft. in another heading, blasting was discontinued. The contractor's superintendent, Daniel O'Connor, made a trial of pneumatic hammers, and almost from the start these demonstrated themselves as the successful solution of the difficulty.

The first bits tried were 1-in. diameter steel with 1-in. chisel-shaped cutting ends. The hammers were of small size (Ingersoll-Rand chipping or scaling hammers). Increased speed of mining and decreased danger of roof falls resulted, and the exhaust from the tools also aided ventilation. After nearly nine months' experience with this method of excavation the opinion on the work is that the pneumatic hammers have solved the problem of mining in stiff soil and also dealing with ground in which the stratification changes rapidly.

The hammer is used to scale off pieces of the soil, being held almost parallel to the face. The bit in most cases is slightly bent forward at the point to facilitate the flaking-off process. Several different forms of bit were evolved as the work went on. Referring to the drawing, Fig. 3, the narrow chisel was found to operate well in hardpan and in gravelly clay. The wide bits were used for mining in sticky clay and in plastic clay, after the narrow chisel proved itself a failure. The wide bit was satisfactory for every operation in the sticky clay and would remove in one bite from one to two shovelfuls of soil.

The progress made with the hammers may be judged by the average figure of 3.70 lin.ft. per 10-hr. shift, with the pneumatic hammers, against 2.84 lin.ft. in the same time with hand pick work. The excavation quantities corresponding to these two figures are 14.17 and 11.84 cu.yd. This was in semistable soil. The average progress in stiff blue clay, using the pneumatic hammers, was 6 lin.ft. in 10 hr. (June, 1916).

Box-Drift Advance with Clay-Plastered Surface

Open gravel strata and water-bearing strata presented very serious problems, which were met finally by the adoption of box-drift advance with full clay plastering of all surfaces, both of soil and timber. The development may be sketched by detail reference to the north heading from Shaft 2.

Originally, work was carried on in this heading without compressed air. About a month after beginning the excavation, the first face collapse occurred, at Sta. 1 + 16.5; it brought in a mass of sand, gravel and boulders and 300 gal. of water per min. From that time until successful junction with the south heading of Shaft 1 the work continued to be an unending battle to drive ahead. This is best shown by the fact that 780 ft. of advance was made in eight months, or less than 100 ft. per month. All of this was through running sand and gravel deposits in at least a part of the face.

After the first collapse, compressed-air equipment having been installed, the heading was placed under air pressure on Nov. 5. Low pressure on Nov. 17 and 18, the air dropping to 9 lb., brought more face collapses and increase of water, the inflow now amounting to about 600 gal. per min. The water was driven back by increasing the air pressure to 13 lb. On Nov. 29, at Sta. 1 + 54, after various attempts to grout the collapsed heading, work with a different method of advance started. A narrow top heading or box drift, 5 ft. wide at the top, 8 ft. 3 in. wide at the bottom and 6 ft. 6 in. high, was started. This box drift employed three-segment timber sets of 20-in. longitudinal spacing, and such a sequence of operations that only a very small area of ground was

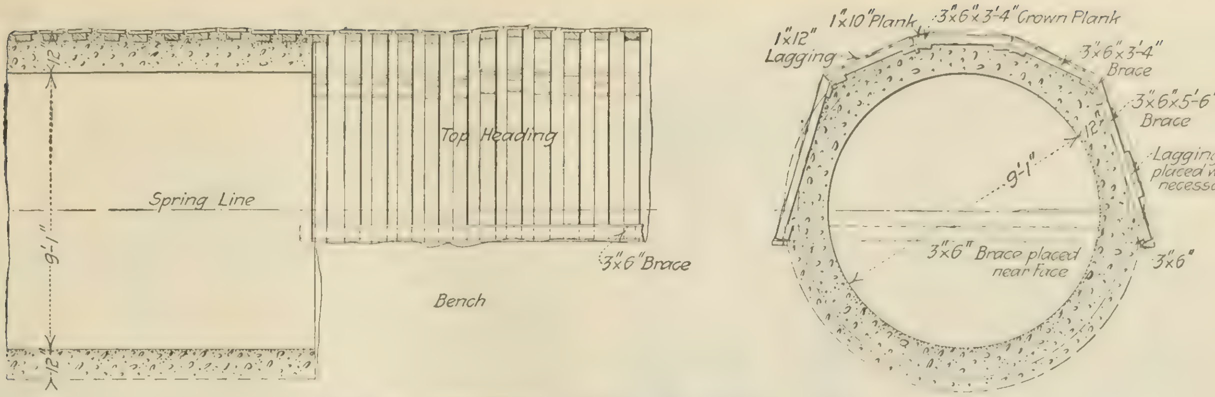


FIG. 4 TIMBERING USED IN STIFF CLAY

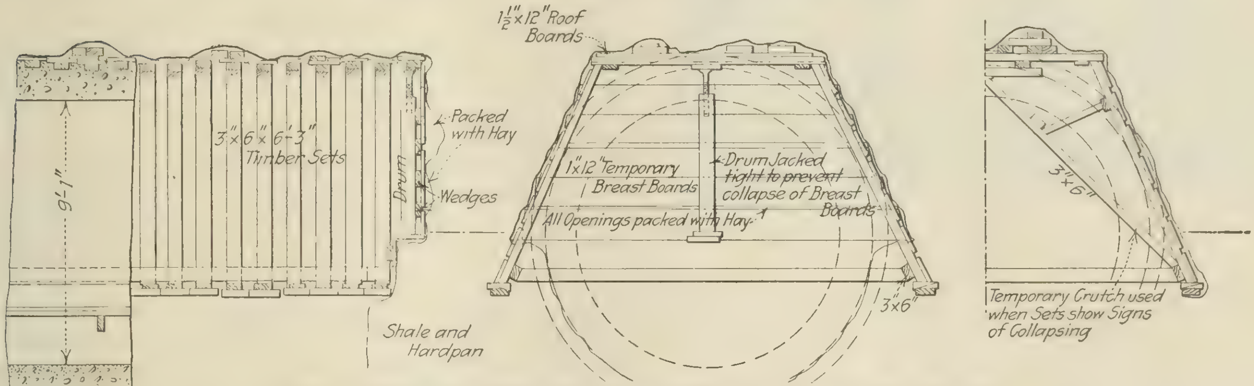


FIG. 5 TIMBERING USED IN LOOSE SATURATED SAND AND GRAVEL

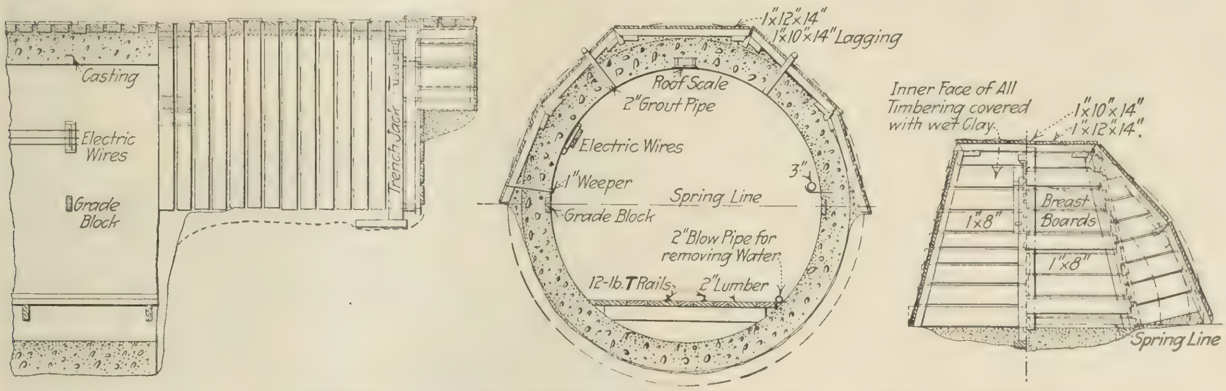


FIG. 6 TIMBERING OF CLAY-PLASTERED BOX DRIFT, USED IN WORST GROUND

FIGS. 4 TO 6. DIFFERENT ARRANGEMENTS OF ARCH TIMBERING USED IN THE SHORE TUNNEL

exposed at any one time, at all other times both exposed soil face and timber being covered tight with a plastering of soft clay. Fig. 6 sketches a heading timbered under this system, and may be compared with the normal timbering of Figs. 4 and 5.

The advance of the box drift is made by 20-in. bites until a 10-ft. advance is obtained. The first step in the advance is to remove the top breastboard and then take away the soil for a horizontal depth of 20 in. and a vertical depth of 10 in. Roof boards 1 in. thick, 10 in. wide and 20 in. long, with long edge parallel to the tunnel axis, the top surface covered with soft clay, are placed in the small area of roof exposed. Then two 3x6-in. transverse crown timbers 5½ ft. long are laid against the roof boards. These timbers are held temporarily by a 3x8-in. cantilever crown bar 6 ft. long supported by a trench jack until the side pieces of the three-piece set can be installed. The 10-in. face of the excavation for the new roof boards is quickly covered by 1x10-in. breastboards, also clay plastered, and braced against the trench jack. Then the entire breast is brought to the new face by successive 10-in. vertical depths of advance, placing the new breastboards in 10-in. sections. As the excavation of this 20-in. bite progresses and the sides of the box drift are exposed, these are covered with 1x10x20-in. boards clay-plastered on the outer surface. This side sheeting is held by the legs of the three-piece set when placed. The crown timber of the three-piece set is permanent, as it becomes the crown timber of the final five-piece set of the full-sized excavation.

When the box drift was first started, a heavy escape of compressed air passed through roof, breast and sides, and it was found necessary to cover all surfaces with clay, thoroughly wet. This use of clay has been continued. Fig. 1 shows a heading where the application of clay is just started.

The clay plastering has been made an essential feature of the excavation in loose ground. Constant vigilance is required to prevent blows, and generally one man is detailed to the sole duty of going over the clay plastering

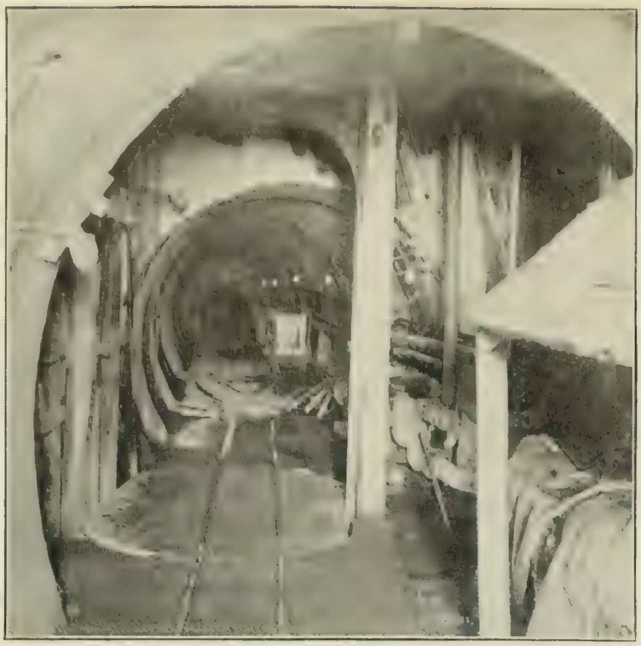


FIG. 7. HEADING FROM FOOT OF SHAFT 2, LOOKING TOWARD AIRLOCK

that covers sheeting and timbers, and closing cracks and holes as fast as they appear under the drying-out effect of the air.

Full-section excavation is made as soon as the box heading has reached a 10-ft. advance. The widening out is done with precisely the same care to expose only a very small area as in the advance of the heading. The widening is done in two stages, roof to spring line being done first with completion of the permanent five-piece timber sets, and excavation of the lower half of the section then following.

The condition of affairs when the box drift was first employed was that the face consisted of fine brown sand above the spring line and in the roof, and stiff red clay in the lower half. The clay, however, gradually disappeared as the heading advanced, and ultimately dropped to near the bottom, with gravel below it. Under these circumstances, longitudinal 1x10-in. planks had to be installed along the entire lower half of the excavation, whereas elsewhere sheeting was used only above spring line (or above the footing plates of the sets where these were carried down lower).

The clay-plastered box drift was continued in the north heading of Shaft 2 for about 240 ft. It was also used successfully in excavating through a full deposit of water-bearing sand from Sta. 9 + 70 to 10 + 44 in the south heading of Shaft 1. The average progress of the full-section excavation with the box-drift method has been 1.27 ft. in the 10-hr. shift.

The advantages of the system are that only a small area of ground is exposed at any one time, which lessens the air loss and danger of a run of soft soil, and the fact that the very short advances at the face give almost sure control of the soil. The almost perfect control of air loss by the clay plastering has proved an especially valuable feature of the method.

Successful drainage of wet face and wet benches has been accomplished by pumping from well points driven into the face or bench. This expedient was suggested by George W. Jackson, member of the contracting firm, in the case of a bad collapse in the south heading from Shaft 2, Sta. 9 + 81, when water was coming in at the rate of 200 gal. per min. and the air pressure, even though raised from 11 to 27 lb. per sq.in., was unable to control it. As the hydrostatic head corresponding to lake level was only 12 lb., it was unsafe to raise the pressure further, and the water had to be brought under control before face excavation could continue. Well points were driven 18 in. into the face about 3 ft. below the excavation roof. The material was fine sand above springing line and soft clay below.

Draining Face by Well Points Driven Ahead

Fig. 9 sketches the arrangement of the well points. They were all connected by hose to a valved manifold placed upon the 3-in. blowout line; a ¼-in. hole in the blow pipe for admitting air at tunnel pressure gave an ejector effect to supplement the inward pressure at the well points. On opening the valves, the pressure of the air acted through the mesh of the well points and the blowout line, and the well points then were the natural place of escape for the compressed air, which carried the water with it. The result was very successful. Four 1¼-in. well points easily controlled the inflow from the face and dried the roof.

The air pressure in the drift was 27 lb. at the time the well points were started. The pressure was gradually reduced to 13 lb., the well points continuing to operate with excellent results.

Later, the well-point method was used to drain wet benches in fine sand, with equal success. It is the opinion of those who have seen the well points in service in this heading that an important advance in tunneling has been made by the employment of this method. Their use gives control over a wet face in soft soil that cannot be controlled by the aid of compressed air alone at moderate pressure.

FIG. 8. LOWERING STEEL AIRLOCK DOWN SHAFT 2

After a collapse of timbering in one of the headings, due to undermining of a footing plate, the 8-ft. open length of heading in soil of gravel and boulders caved in. To recover this heading by direct mining in a disturbed soil would have been a very dangerous procedure.

Grouting a Collapsed Heading

A 9-in. concrete bulkhead backed by a 3-in. timber bulkhead, was built immediately as close to the point of collapse as possible, and the heading was grouted through a pipe passing through the two bulkheads. Grout was pumped in to the point of refusal, and the heading was then abandoned for two weeks to allow the grout to set thoroughly. When it was reopened the solid grout and cemented gravel and boulders were mined through by pneumatic hammers without any difficulty or mishap. Timbering was not required, as the grout formed a solid mass that was completely self-supporting over the arched excavation.

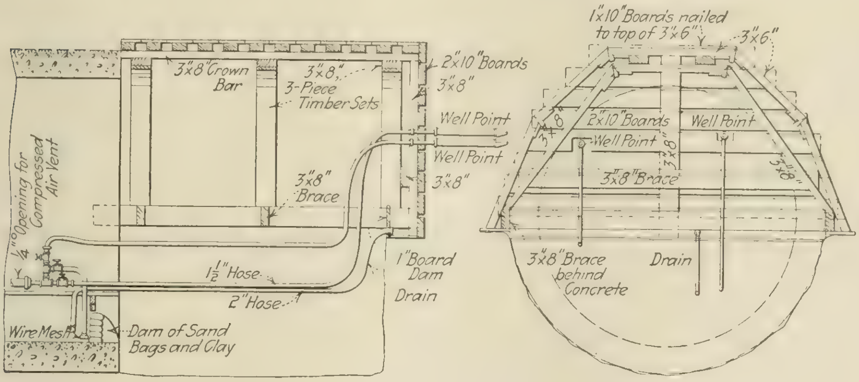


FIG. 9. HEADING FACE DRAINED BY WELL POINTS

Different Kinds of Timbering

In all headings the excavation has been carried out in top-heading and bench arrangement. The top heading usually extended down about a foot below spring line, making the bench about 5 ft. high. The nature of the ground and the resulting method of timbering, however, affected the height of bench considerably. In the stiff clay the arch was held by timber sets founded on foot blocks, usually at or 12 in. below springing line (Fig. 4). These were five-piece segmental sets of 3x6-in. maple, consisting of a crown timber 42 in. long and two 48-in. side segments on each side, all framed with beveled joints. The sets were spaced to suit conditions, from tight setting to 5-ft. spacing. This type of timbering would not hold heavy earth pressures, yet it served to prevent movement of the roof soil and also held any small chunks or slabs of loosened material, thereby lessening the danger to the men.

In softer soil, as sand and gravel, the timbering usually consisted of three-piece sets of 3x6 maple (Fig. 5), with a 6½-ft. crown timber and 7-ft. legs resting on plates or footing blocks set well below springing-line level and giving in effect an almost flat floor, which was secure and stable except in a very few cases where invert planking had to be put in. These sets were placed solid, edge to edge.

In those soils where the box-drift method of excavation was resorted to, the standard three-piece set was not adaptable, as it would have required double roof timbering. A modified five-piece set was used here, of such arrangement that the crown timber of the box drift served also as crown timber of the permanent five-piece set, making the bench about 5 ft. high ordinarily. The excavation ranged from 2.28 cu.yd. to 2.68 yd. per lin.ft. in the heading and 1.40 to 1.65 cu.yd. per lin.ft. in the bench.

An advance of 9 ft. before concreting was first tried. This was gradually lengthened, however, with experience and practice to a maximum of 15 lin.ft. of advance wherever the stability of the excavation roof permitted. In all cases concreting followed, section by section, immediately behind the excavation, each section being concreted close up to the face. The contractors paid close attention to limiting excavation to the neat line, but the nature of the soil and the rapidity of its changes prevented entire success in this effort. There has been surplus excavation throughout, the average amounting to 0.20 cu.yd. per lin.ft. outside the line of the 12-in. shell. This amount was measured by the concrete put in for the lining. Part of this is accounted for by the considerable departure of the invert from the theoretical semicircle where the timber sets are carried down well below springing level, as shown in the drawing in Fig. 5.

Engineers and Contractors

The whole construction is being conducted under the charge of George F. Staal, City Engineer, the writer supervising the construction operations. The contractor is the O'Brien & Jackson Construction Co., of Chicago; Daniel O'Connor is superintendent. The forces maintained by the city on the contract comprise five construction inspectors, two engineering inspectors, one transitman and one draftsman, besides the resident engineer.

Local Engineering Society Makes Influence Felt—"Some progress has been made in the direction of taking a more active part in the public affairs of the city and state. This is one of the principal objects of the Oregon Society of Engineers, as specifically set forth in its constitution—namely, to organize engineering opinion in matters of public interest. One of the great advantages that a local engineering society has, over the local branch of a national society is the freedom which it has to enter more closely into the life of the community in which it exists. The national society is bound to a certain extent not to voice its sentiments on questions of public interest without first consulting the parent organization. This greatly handicaps it in such action, owing to the time required to get permission to act and the probability that on certain questions such permission will not be granted. The Oregon Society of Engineers, however, is entirely free to take any action it may see fit in any given case, and only needs to exercise caution not to be rushed too freely into expressing its convictions in a public manner. Such work as the society has done in this connection has been largely in the way of committee work directed by the executive board, and may not have been fully noted by many of the members. One of the earliest endeavors in this line was made nearly three years ago, when the society put forward for the nomination of city commissioner a well-known engineer and materially assisted in placing him in office and at the head of the department of public works. The result of this action has, I believe, been beneficial to the city and creditable to the profession, and the society has no need to regret its action in the matter."—Williams S. Turner, in a presidential address to Oregon Society of Engineers.

Activated-Sludge Plants at Houston, Texas

By C. L. Williford*

SYNOPSIS—Two activated-sludge plants with a combined capacity of 19,000,000 gal. a day, with continuous-flow aëration tanks, vertical-flow settling tanks, sludge-reaëration tank, rotary positive-pressure blowers and pitot-tube air meters.

The construction of activated-sludge plants with a total capacity of 19,000,000 gal. per day is now well under way at Houston, and it is expected that the plants will be ready for operation by April 1, 1917. Though a comparatively new method of sewage treatment, it was shown by thorough tests under working conditions to have considerable advantages over older methods and was adopted as being best suited to all the requirements, local conditions and natural advantages. The prevailing mildness of temperature, the condition of the sewage after passing through an extended sewer system and being pumped, the small area required, the absence of objectionable odors and the large removal of suspended matter were some of the factors considered in the selection of this method.

Preliminary tests were conducted over a period of one year, the last four months being directed solely to the activated-sludge method. A description of these tests and their results are amply set forth in a recent printed report by the City Engineer, E. E. Sands, under whose direction they were made.

The present population within contributing distance of the plants is estimated at 140,000, about half of which is now connected to the sewers. The sewers are built upon the separate system. All the sewage is passed through screens having 1-in. openings, chiefly for the purpose of protecting the pumps, and about two-thirds of the total is passed through a grit chamber. In order to utilize a number of miles of sewers constructed some time previously in pursuance of another plan of disposal, it was necessary to build two plants, on opposite sides of the city. It was desired to provide for a total population of 225,000 connected to the sewers. Gagings placed the present average flow at 85 gal. per capita per day for the population connected to the sewers, and this was used in estimating the quantity to be treated.

The plants have been designed in units for convenience and flexibility of operation. The north-side plant consists of four units, and the south-side plant of two units. Each unit is capable of treating the sewage of 37,100 persons, giving an average flow of 2,190 gal. per min., and

*Assistant Engineer, City of Houston, Tex.

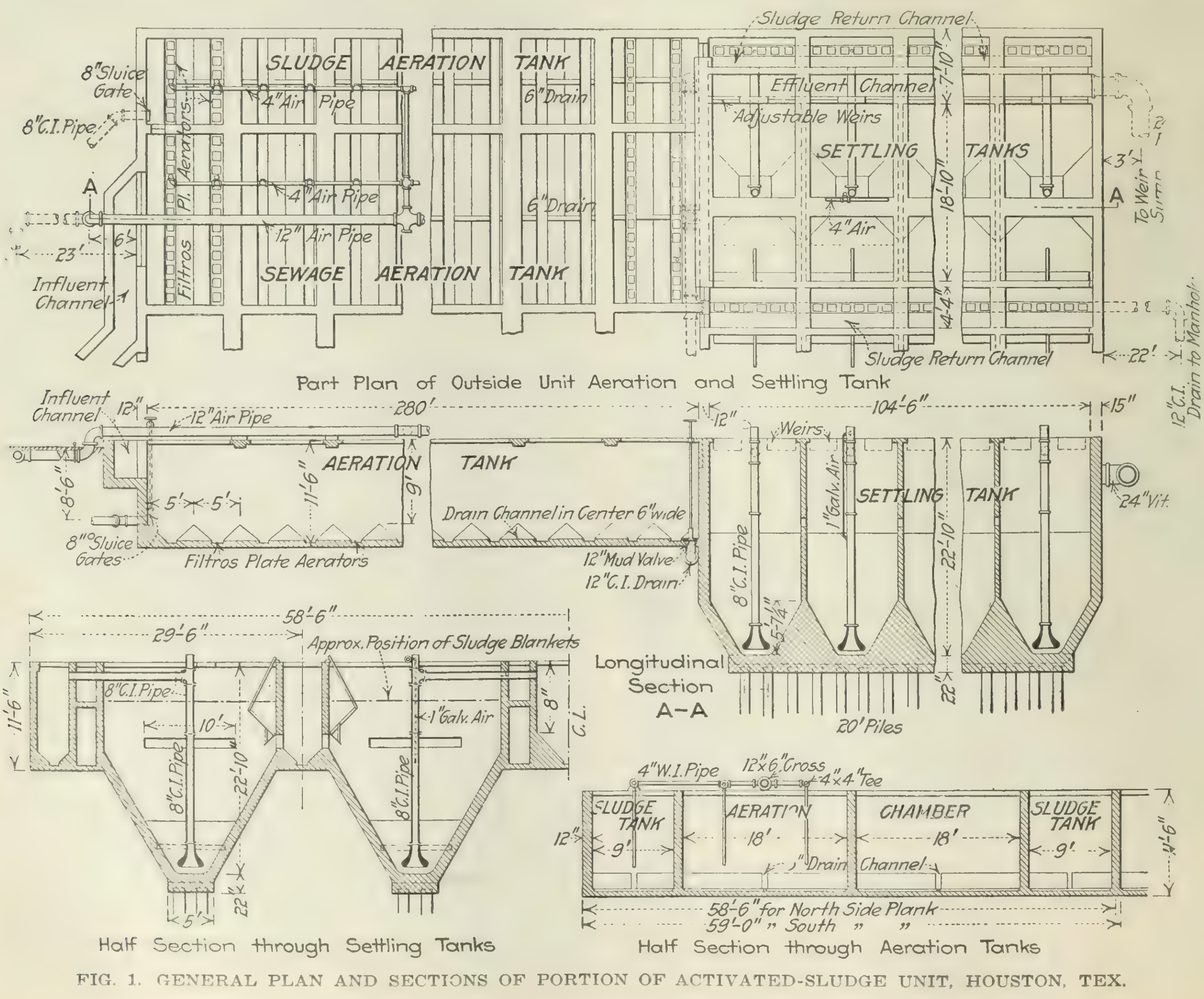


FIG. 1. GENERAL PLAN AND SECTIONS OF PORTION OF ACTIVATED-SLUDGE UNIT, HOUSTON, TEX.

a maximum flow of 2680 gal. per min. per unit. Each unit consists of a rectangular continuous-flow aëration tank, a battery of 10 vertical-flow settling tanks and a sludge reaëration tank, the whole supplied with means for distribution of air under a pressure of 5¼ lb. per sq.in. (See Fig. 1 for plan and sections of a part of one unit.)

Each aëration tank is 18x280 ft. in plan, with a net depth over aërators of 9 ft. 9 in. The net volume of the

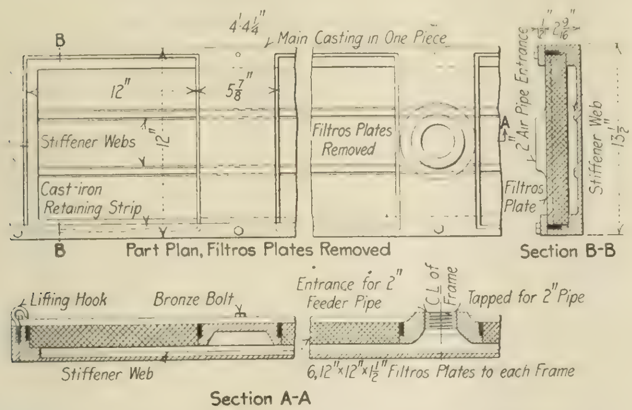


FIG. 2. FILTROS PLATES AND FRAMES, HOUSTON, TEX.

tank when full is 340,000 gal. The ratio of tank surface to tank volume is 1 sq.ft. to 67.4 gal. Grade 5-1 filtros plates, 12x12x1½ in. in size, are set in the bottom of the tank in cast-iron frames (see Fig. 2). The frames are placed in rows across the bottom of the tank, spaced 5 ft. c. to c., for the full length. There are 112 frames to each tank, each frame holding six aërator plates, giving a total of 672 aërators to each tank. The ratio of aërator surface to tank surface, then, is 1 to 7½. The tanks will be supplied with 0.26 cu.ft. of free air per minute per square foot of tank surface. The average detention period in the aëration tanks will be 1 hr. 50 min., and the minimum 1½ hr. Allowing 30% of the volume of the tank to be occupied by sludge, the average unit volume of free air supplied will be 0.33 cu.ft. per gal. of sewage per hour treated.

After aëration the mixture of sewage and sludge will flow directly to the settling tanks through a channel 4⅓ ft. wide, 9¾ ft. deep and 104 ft. long. This channel has aërators placed at intervals in the bottom to prevent settling of sludge. The 10 settling tanks are placed in a row beside the channel, and large slots with adjustable gates connect the channel with the tanks. The settling tanks are 10x18 ft. 10 in. in plan and 21 ft. 10 in. from water surface to bottom. They have conical bottoms and are supplied with vertical 8-in. pipes in the center, fitted to act as air lifts to remove the settled sludge. The volume of each tank is 22,000 gal. They are designed to act on the vertical-flow principle, the path of the sewage being across and upward to the effluent weirs on the opposite side from the distributing channel, while the direction of motion of the settling sludge is downward. It is proposed to maintain a blanket of sludge somewhat below the surface to act as a strainer to remove fine particles of sludge in suspension. This necessitates a very low velocity of flow in the tanks, since the sludge is very light and extremely sensitive to impelling currents. It is estimated that this velocity will be about 2.7 ft. per min. It cannot be said at this time just how successful this plan will prove, and it will be an interesting feature of operation to be observed. The design is such, however, that a simpler method of sedimentation can be resorted to if necessary. The effluent passes from the settling tanks to a collecting channel and thence to the river without further treatment.

The settled sludge is removed from the settling tanks by the air lifts and flows into a sludge-collecting channel that leads into the end of the reaëration tank. This tank is 9x280 ft. in plan, of the same depth as the aëration tank and, except for width, is identical with it in construction. The concentrated sludge is here aërated for an average period of 3 hr. and reënters the aëration tank at the influent end to become mixed with the sewage again. Excess sludge will be pumped from the end of this tank for further treatment. The volume of air supplied to the sludge in reaëration is 0.23 cu.ft. of free air per gallon per hour aërated. Under normal conditions it is believed that the rate of flow can be increased 25% above that for which the plants were designed, without increasing the volume of air supplied.

All tanks and channels are built as monolithic structures of reinforced concrete. Walls have been designed for full earth pressure outside and full water pressure inside. All concrete will be waterproofed with integral waterproofing. Sloped walls in the settling tanks will receive special trowel finish to prevent accumulation of sludge. Great care has been taken to avoid dead spaces and corners where sludge could accumulate and become septic. Short-circuiting and inadequate aëration of any part of the sewage are thought to be entirely avoided. There are no sludge channels or pipes without means of thorough agitation.

Wrought-iron pipes for air distribution, ranging in size from 12 to 4 in. diameter, are carried on small slabs across the top of the tanks. Vertical 2-in. galvanized pipes connect the distributing system with the aërator frames. All bolts and screws in contact with sewage are made of bronze. Valves are placed at advantageous points throughout the system to facilitate control. The volume of air supplied will be measured by meters (Fig. 3) fitted with pitot tubes and a differential gage, placed between the blowers and the tanks. Air will be supplied by rotary positive-pressure blowers made by the B. F. Sturtevant Co. Each blower has a capacity of 3750 cu.ft. per min. at a pressure of 5¼ lb. per sq.in. Three blowers will be placed at the north-side plant and two at the south-side plant. Four of the blowers are driven by 150-hp. 3-phase

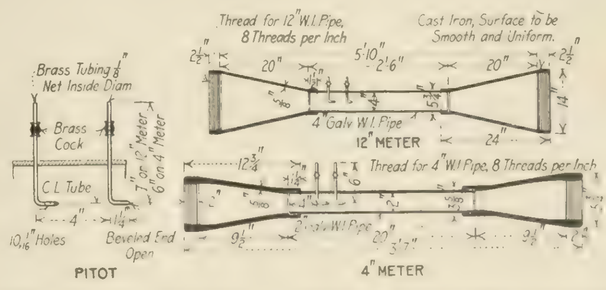


FIG. 3. AIR METERS, HOUSTON ACTIVATED-SLUDGE PLANT

60-cycle 2200-volt motors made by the General Electric Co. At each plant there will be one constant-speed motor and one multiple-speed motor. At the north-side plant one blower will be driven by a 150-hp. twin Standard fuel-oil engine of the Diesel type. This engine is being installed for the purpose of reducing the power consumption at the plant at the time of peak load at the generating station, by which arrangement an advantageous power

rate was secured. Power will be furnished by the Houston Lighting and Power Co. Air will be filtered through muslin screens before entering the blowers.

Brick buildings of substantial design and pleasing appearance, equipped with traveling cranes, are being erected as power houses at the plants. A frame office and laboratory building is provided at the north-side plant, and a small office and storeroom at the south-side plant. All laboratory work will be conducted at the north-side plant, and it is intended to operate the plants under capable supervision in conjunction with thorough chemical and biological analyses.

Plans for the final disposal of sludge are being held in abeyance at this time, awaiting the development of better methods. A large amount of work is being done elsewhere along this line, and it seems probable that an efficient and acceptable method will be worked out in the course of the next few months. It appears probable at this time that final settling tanks and mechanical presses and driers will be the method used. A centrifugal pump of 500 gal. per min. capacity is provided at each plant to deliver the excess sludge to the dewatering apparatus. Three fertilizer plants are located in the city, and it is expected that all the available sludge will be consumed locally. It is impossible to give at this time even an approximate estimate of the quantity of sludge to be expected since this is a rather variable item and one not easily calculated.

To avoid the use of force mains from pumping stations to the plants a large amount of excavation was necessary for the construction of the plants. At the south-side plant 20,000 cu.yd. of material was removed, mostly loam and stiff clay. At the north-side plant 90,000 cu.yd. was removed, consisting of sand, clay and marl. This excavation was done at a unit price of 27½c. per cu.yd., the material being removed from the site. The top of the tanks at the south-side plant is 6½ ft. below the natural ground surface. The north-side plant is situated on sloping ground, and the average depth from natural ground surface to the top of the tanks is approximatly 12 ft. The excavated areas are sufficiently large to provide ample room around the tanks. Banks are cut on 1½ to 1 slope and will be sodded to prevent erosion. The excavated area at the north-side plant is 3.2 acres, and at the south-side plant 1.3 acres.

The following construction costs taken from contract prices are here given:

	North Plant*	South Plant†
Excavation	$24,750	$5,500
Contract price, plant complete, except machinery	186,550	88,050
Machinery and equipment (purchased by the city)	22,184	9,760
Estimated cost of sludge-handling equipment	20,000	10,000
Total	$253,484	$113,310
Total cost both plants		$366,794
Cost per million gallons per day capacity		19,305
Cost per 1,000 contributing population		1,630

* North-side plant, 12,615,000 gal. capacity per day. † South-side plant, 6,310,000 gal. per day.

When conditions become such that the plants are operated at full capacity, it is estimated that the cost of treatment will be $9.15 per million gallons per day, including interest and depreciation. It is evident that both construction and operating costs would have been somewhat reduced if it had been possible to build one central plant instead of two separate plants.

The layout of the plants is compact, and the design is such that additional units can be provided when needed, without alterations to the present structures. The plants require an almost inappreciable hydrostatic head for their operation. The head to create circulation of the sludge is maintained by the air lifts in the settling tanks.

Filtros plates for distribution of air are not considered altogether satisfactory in some respects, but being the best method available at this time, they will be installed and given a trial. It may be worthy of mention that a plate used for four months under adverse conditions in an experimental tank was recently broken and showed a clean fracture with only a very thin line of deposit on the upper side.

The degree of purity expected from the effluent of these plants is indicated in a general way by the following:

Oxygen consumed	88 to 90% removed
Suspended matter	95 to 98% removed
Nitric nitrogen present	7 to 10 p.p.m.
Bacteria per c.c	95 to 99% removed
Relative stability number	100 (Phelps test)

In connection with this work, the Willow St. pumping station is being rebuilt and equipped with new machinery, and one new pumping station is being constructed. In addition to this, several miles of 36- and 42-in. gravity mains have been constructed from pumping stations to disposal plants. A later article will describe these.

The contract work is being executed at the north-side plant by Horton & Horton, and at the south-side plant by Jerome Cochran, Jr. The general features of design are the work of Mr. Sands. The writer is in charge of design and construction of sanitary sewers and disposal works.

Recommended Practice in Concrete Road and Pavement Construction*

By H. Eltinge Breed†

The following observations are based upon such knowledge as may be gained by inspection of concrete pavements in various parts of the country, and, more validly, on the actual construction in New York State of 201 mi. of second-class concrete pavement, 1 : 2½ : 5 mix, a type which we have ceased using; and upon the actual construction of 364 mi. of concrete pavement, 1 : 1½ : 3 mix, built in the last four seasons. There still remain 127 mi. of this type of construction under contract.

General Pointers

Maximum Grades—Our original practice was not to exceed 5%, but today we are building pavements on grades as steep as 8%, under certain conditions. Grade seems to be limited only by the ability of the wet concrete to run during the process of construction, by the character of the mix and the kind of traffic.

Minimum Widths—Most of the roads we have been building in New York State are 16 ft. in width. It would be far better, however, and ultimately more economical, if we had sufficient funds to build them 18 ft. wide. For two lines of traffic on a concrete road 18 ft. should be the minimum width; for three lines, 24 ft.

Square-Cornered Edges—The edge of the concrete slab next to the shoulder should be vertical and square cornered. Then if it becomes necessary to reinforce the shoulder with road metal a good joint can be made; and,

*From a paper, "Best Practice in Concrete Road Construction," read Feb. 7, at Seventh American Good Roads Congress, Boston, Mass.

†First Deputy Commissioner, New York State Highway Department.

more important still, if additional widening is required, it can be accomplished with a longitudinal joint of minimum size. We have very satisfactorily widened some miles of square-edged concrete roads.

Essentials of a Good Subgrade

1. It must have uniform bearing power. If an old roadbed is to be used it must be scarified, reshaped and rerolled for the entire width of the pavement, removing all large stone to a depth of 6 in.

2. It must be dry. Ditches should be low enough to take away the water from under the pavement. With unstable soil good results can be secured by providing subdrains and spreading a layer of gravel—preferably run-of-bank gravel—over the subgrade to increase its stability. Material used for this purpose must be impervious; if it is porous it will act during wet periods as a reservoir, which, under conditions of frost will break the pavement proper.

3. The pavement should be reinforced: (a) under very bad, i.e., unequal soil conditions; (b) wherever the supporting power of the subgrade changes; as from rock to earth, or passing over a trench. Our experience indicates that the expense of reinforcement is not justified in gravelly or sandy soils where good natural drainage prevails.

Proportioning the Mixture

With our requirements for materials we have found that the proportion of 1 : 1½ : 3 gives the greatest density. Our specifications provide that the concrete shall be mixed in the proportion of one volume of cement to 4½ volumes of sand and broken stone or gravel, and the proportions of fine and coarse aggregate are varied slightly as a result of field tests for void to give greatest density.

Stone—The coarse aggregate should consist of a well mixed product of clean stone, No. 1 (retained on ⅜-in. and passing ⅝-in. circular opening), No. 2 (⅝ to 1½-in.) and No. 3 (1½ to 2¾-in.). Not more than 25% of the total should be No. 1. We allow as our maximum size stone that will pass a 2¾-in. ring, while most specifications permit only 1½-in. stone as a maximum. Our reason for the increase in size is that better results are obtained at less cost. We save 15% in crushing costs by this use of larger stone.

Sand—Sand should be such that 100% passes the ¼-in. screen; not more than 20% a No. 50 sieve and not more than 6% a No. 100 sieve. However, where more than 20% of the sand passes a No. 50 sieve, where it is well graded to give a low percentage of voids, and where it conforms to all other requisites, special permission for its use may be given. It should not contain more than 5% silt or loam.

Importance of Field Tests

Our work has shown that if we are to omit any of the tests, we might better take a chance with the cement, for of the last 455,000 bbl. used only 1.4% failed to conform to the test of the American Society for Testing Materials. There has been a far greater proportion of both sand and stone rejected.

The principal tests which can be made in the field accurately enough for all practical purposes are:

1. Gradation tests for sand. Our field men are furnished with sand testers which have the ¼ in., the No. 20 and the No. 50 sieves. By using these they can be assured of getting a uniform product from the bank, for they would at once detect any change for the worse in the character of the material and would reject it. Each engineer is supposed to make a daily report of the gradations. A laboratory test, however, is essential to ascertain the presence of any deleterious matter in the sand.

2. Test for loam and silt content in sand. This can be made in the field and checked up by the laboratory results. For the loam test, an excess of water is added to a given quantity of sand in a glass graduate, the whole is well agitated and allowed to stand until the loam and silt has settled on top, when their percentage may be measured.

3. Test for set. This is made by mixing the sand with cement and forming a pat with thin edges. By breaking the edges after 24 to 48 hours it may be determined how the material sets.

4. Tests of stone and gravel. Field determinations of these materials can be made only for voids. Visual inspection should of course detect soft material and dirty aggregates.

Field Tests of Concrete

Concrete from a batch mix is made up on the road into 6-in. cubes two in number from every 500 cu.yd. of material. They are cured for 21 days in moist sand and then shipped into the laboratory and tested at 28 days. The results of these tests are given to the engineers on the work and the rivalry to have the highest test value produces good results. It is expected that these cubes shall go over 3000 lb. per sq.in. compression, and if they don't we look for trouble. Of 504 cubes tested in 1916 only 13¼% tested below 3000 lb. Nearly 90% of these failures were from dust or silt coated coarse aggregate, and from fine aggregate leaving an excess of loam or made up of excessively fine grained sand.

These tests also showed an average of 3370 lb. compression for all 1 : 1½ : 3 mix cubes, stone and gravel aggregates, while the average for the stone aggregate cubes was 3380 lb. and the average for the gravel aggregate cubes was 3080 lb. Thus it is demonstrated from these tests that stone concrete is 11% stronger than gravel concrete. In comparing the two, it is fair to say that all gravels with a coating that ordinary washing will not remove should be rejected; while stone that retains much of the dust of fracture is bound to make weak concrete—this is especially true of all soft limestones, and of any stone that is crushed when it is wet.

Suggestions on Construction Details

An exact subgrade is necessary to save the concrete that would be wasted in leveling inequalities in the foundation. The extra time and attention spent on getting an exact subgrade will be well repaid. Steel forms, while more costly than those of wood, are far more economical in the long run and pay for themselves in a short time.

The concrete should be well spaded and kept high above the screed or strikeboard on the mixer side. Tamping should not be allowed. In screeding, the screed should be slowly pulled back and forth, advancing it slowly with each operation. When approaching a joint the screed should be brought up to the joint and carried back in order that the surface may be uniform. No more floating than is absolutely necessary should be resorted to as the primary object is to have the wear on the surface taken by the stone, and not by the thin mortar layer produced by floating.

Notes from Field and Office

Flat-cars remove spoil from building excavation in New York—Hauling stone by motor truck—Cost of small sewer system—Steel derrick of box-plate section

Trains of Standard Flat-Cars Remove Spoil from New York Excavation

The deep excavation for the Commodore Hotel at 42nd St. and Lexington Ave., New York City, is almost entirely in rock. The southern portion of the site is crossed by a subway link connecting the new Lexington Ave. subway with the old line on Park Ave. The standard depth for the excavation is about 50 ft. below street level, except for a strip 75 ft. wide, extending the full 275-ft. width of the site. This latter portion will go down 100 ft. below street level and will contain a power plant designed to serve as an auxiliary to the 50th St. plant of the New York Central.

To drill the rock, 21 "Jackhamers" are used. A steel-sharpening shop is maintained on the job. The compressor—housed in the central shanty, Fig. 1—is a 1200-cu.ft. "Imperial," driven by a 200-kw. electric motor. After shooting, the small pieces are loaded by hand into large three-sided skips, which are lifted by derrick and dumped into flat-cars having capacity for about 11 yd. each. The larger pieces of rock are lifted out of the excavation by chains attached to the derrick line. Three stiff-leg derricks handle rock from the deep pit, or rather pits, as there is a rock partition left in to carry one of the standard-gage loading tracks, shown at the left in Fig. 1. The other track is now carried across on a trestle.

The material in the southeast corner, shown at upper right in Fig. 2, is earth and loose rock. This corner is separated from the rest of the excavation by the concrete-inclosed subway. This soft material is loaded by hand into dump-buckets, which are lifted by the derrick shown at the right and dumped into the hopper seen at the far right. This hopper discharges into dump-buckets mounted on four-wheel trucks running on a pair of tracks. The buckets are pushed by hand and dumped into the wide chute. When no flat-cars are available, the chute is blocked by a gate. Otherwise it discharges directly into the cars.

A fifth derrick is mounted on the subway structure. It is of the steel guyed type and like the others loads rock onto flat-cars. A long-boom derrick car was built on the job and is moved about wherever desired. Until

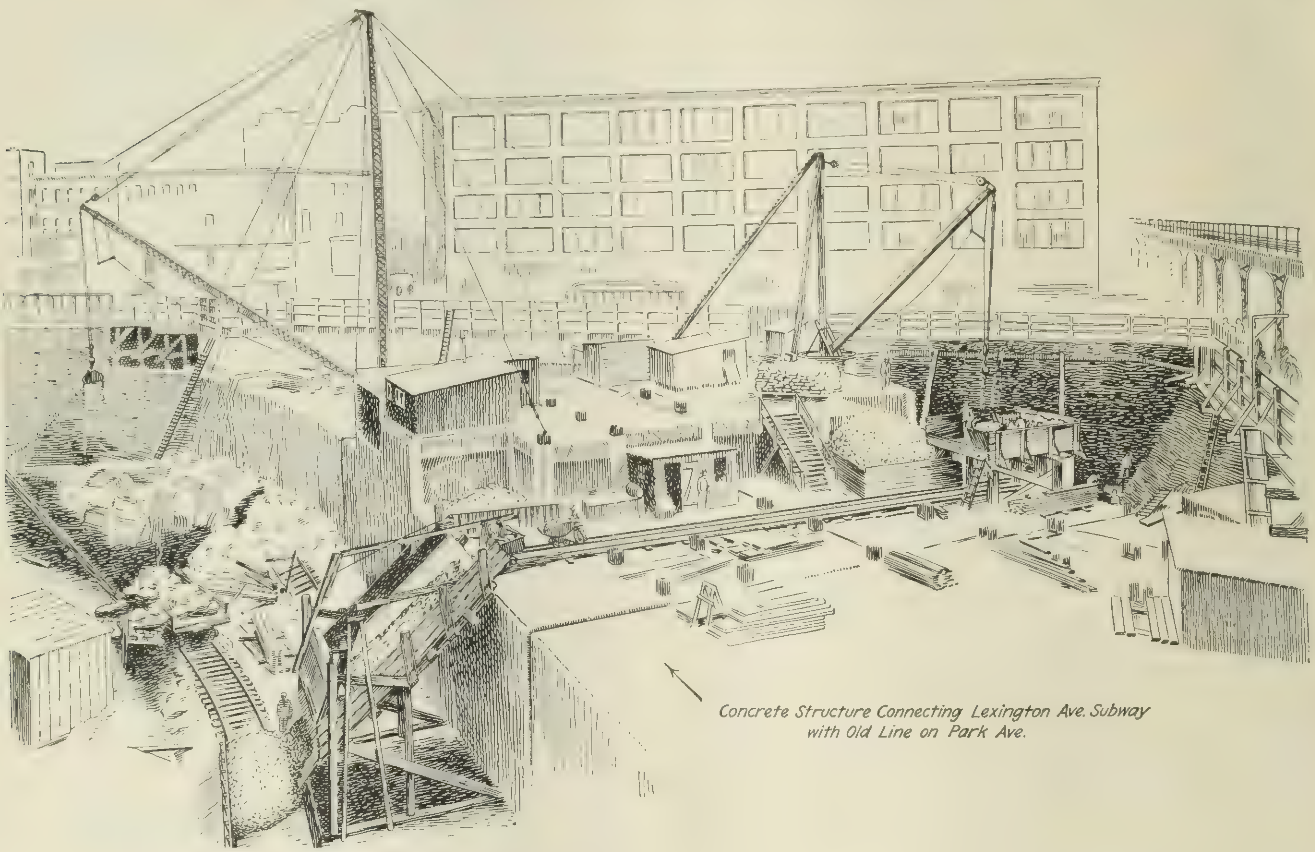


FIG. 1. HANDLING SOFT MATERIAL FROM SOUTHEAST CORNER OF COMMODORE HOTEL SITE, NEW YORK CITY

FIG. 2. GENERAL VIEW OF SITE, LOOKING NORTH, JAN. 8
Deep excavation is for power plant. Brick stack at left is composed of sample face bricks laid up for observation. Flat cars leave site by way of exit shown in Fig. 3

FIG. 3. SHOWING CONNECTION OF SITE WITH GRAND CENTRAL TRACKS

recently there were three loading tracks; one of these has now been taken up. The spoil is being removed at the rate of 400 or 500 yd. per day. Its disposal is simple and cheap on account of direct railroad connection by tracks leading through an opening in the side foundation wall of the Grand Central station, as shown in Fig. 3, to a point on the New York Central line about 40 mi. from New York, where it is used for fill in railroad construction.

The work is being done by the George A. Fuller Co.; D. L. Norris is superintendent on the job.

Hauling Stone for Macadam Roads by Motor Trucks in New Jersey

By James Logan*

Motor trucks of various body capacities have been used on several road contracts in Burlington County, New Jersey, during the last two years, and the experience gained here shows that the cost per ton-mile of hauling road material is about half the figure for teams and indicates in what way maximum economy may be secured.

The dumping-body truck was employed in each case. Trucks of five and ten tons' capacity used on the same job have shown that the smaller capacity is more efficient for short hauls. Stone, when loaded from cars by an unloader, can completely fill the body of a two-ton truck without reversing the position of the truck. The five-ton body is loaded on one side and then has to be turned around and loaded on the other side.

Trucks with power and manual-dumping machinery are each well adapted for certain tonnages—the manual for light capacities and motor lifts for large trucks.

To obtain high efficiency, stone must be ready in the bins of the unloader and trucks must haul over a hard surface. Motor trucks for transporting stone on short hauls should be able to maintain a speed of 15 mi. per hr., should be equipped with steel body and be capable of being readily unloaded. The operation should be such as to warrant the continuous use of vehicles. The truck should never be permitted to stand idle, but should move from cars to road, unload immediately and return to cars again without loss of time.

The character of available roads will influence the cost of hauling. The writer has observed a light truck hauling one ton of material with difficulty on a sandy subgrade, and five tons being hauled with ease at a high rate of speed on a hard compacted gravel foundation.

*County Engineer, Burlington County; Mt. Holly, N. J.

After the material has been hauled to place, the body of the truck may be raised and the end board partly opened so that the stone will fall out in a uniform layer as the truck is started forward. This has been found a very economical way of spreading stone, but it requires practice to attain the correct thickness of the course of material.

The ability of the operator is important; an experienced man will reduce the repair item to a minimum, while a careless driver will increase the cost of hauling by 2c. per ton-mile through excessive bills for parts and repairs. An idle motor vehicle being repaired at the rate of 60c. per hr. is expensive equipment. On the Burlington County work, repairs to trucks were confined to engine, bearings and gears—all of which trouble could be directly connected with the chauffeurs. The repair item may be materially lowered by rewarding with a bonus the drivers who keep the repair bills on their truck below a stated sum.

On the Jobstown Pike near Mount Holly, N. J., four two-ton Autocar trucks, from Sept. 29 to Nov. 29, 1916, inclusive, hauled 3209 tons of 2½-in. broken stone, 1714 tons of 1½-in. and 250 tons of screenings, making a total of 5274 tons. During that time repairs and overhead charges amounted to $506.03, operating expenses were $373.87 and fuel $460, making a total cost of $1339.90. This sum divided by the total tons gives a unit hauling cost of $0.254 per ton of stone. The average round-trip haul was 5 mi. This reduces to a cost of $0.0508 per ton-mile. (It is noticed that repairs plus overhead form the largest item, and these were the expenses that required vigilance.)

On this road contract, which included the rebuilding of a gravel road with 18-ft. macadam, it was necessary to use teams for hauling gravel for binder and shoulders. These teams hauled two tons to a load and made 20 mi. per day. Five dollars a day was paid for a team; therefore, it cost 12½c. per ton-mile to haul that material. This seems to afford a fair comparison with the above figures, as the trucks and teams were in use on the same work at the same time and under the same supervision. The contractor was Charles T. Eastburn Co., of Yardley, Penn. S. M. McFarland was supervisor, and the writer was engineer. Funds for the work were allotted by the state from motor-vehicle fees.

Cost Figures of a Small Sewer System

The cost of the sewerage system of the boom city of Kingman, Ariz., is sent by J. B. Wright, County Engineer. Kingman was the depot of supplies and the stopping place for prospective millionaires during the recent gold-mine rush for Oatman, Ariz. The only water-supply of Kingman was from wells scattered over the town, and the congested living conditions soon made this source of supply so dangerous that the Mohave County Board of Health took prompt and decisive action.

There was in the county treasury a fund of $10,000 to be used for health-protective measures. It was decided to begin at once the construction of a sewerage system. Plans were made for over 30,000 lin.ft. of pipe sewers, serving about 2000 people, with a limit of 7000. Construction was begun in July, 1915, with the small fund on hand, and continued until this fund was exhausted.

As soon as a line was completed and placed in service, the Board of Health ordered the adjoining houses to be connected, charging the following rates for connection: Dwellings, $30; lodging houses, $40; restaurants, $50; laundries, $60; garages, $70; hotels, $80; and other classes of buildings by special agreement, according to service rendered. The funds derived from these connections were credited to the sewer fund and furnished means for continuing the work at intervals until practically the whole town was sewered.

The connections are being made practically as fast as the plumbers can do the work, and the funds paid in for connections will ultimately return the entire cost to the county. All plumbing installed is inspected and conforms to the standard for plumbing in various other cities.

The total amount of sewer constructed is 31,707 lin.ft. at a net cost of 63.3c. per lin.ft., making the total cost $20,073.50. Following are some of the unit costs: Survey and supervision, 3.83c. per ft.; trench and backfill (7400 cu.yd.), 25.59c. per ft.; distributing pipe and manholes, 1.97c.; hauling gravel and cement, 1.04c.; laying pipe, 4.57c.; building manholes and lampholes, 2.21c.; cement, 2.66c.; miscellaneous expense, water pipes, etc., 1.539c.; sewer pipe and fittings, 17.59c.; flush tank, siphons, manhole and lamphole covers, 2.31c. per lin.ft.

Steel-Frame Derrick of Box-Plate Section for Steel Erection

A large guyed derrick with boom and mast of box-plate construction instead of the more common box-lattice construction was employed in the erection of some of the steelwork in the addition to the Morrison Hotel, at Chicago. It was used particularly in erecting the heavy trusses that span the office and other open spaces of the lower floors and support the interior columns of the upper floors. The John Griffiths & Son Co. has the

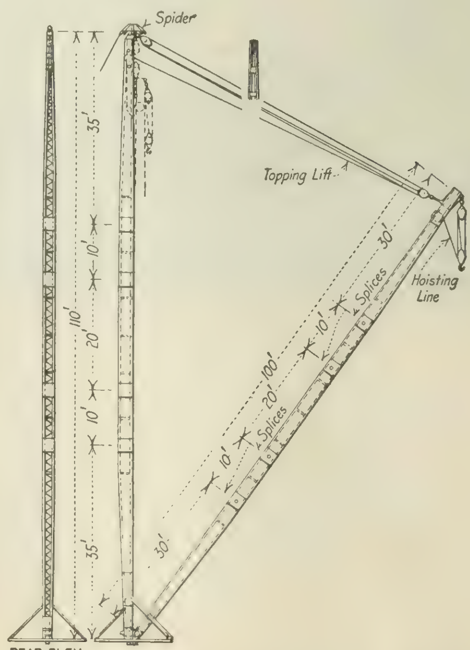


FIG. 1. STEEL DERRICK OF VARIABLE HEIGHT AND REACH

contract and depends upon its lighter box-lattice derricks for the ordinary structural work, but for the heavier work it borrowed this box-plate derrick from the Ketler-Elliott Erection Co. Both of these are Chicago firms. Fig. 2 shows the derrick in use, and Fig. 1 shows the general design.

The details of mast and boom are given in Fig. 3. The mast has two end sections 35 ft. long, two 10-ft. intermediate sections and a middle 20-ft. section. These are put together with ¾-in. bolt splices to provide for varying the height, the maximum extension being 110

FIG. 2. DERRICK OF BOX-GIRDER CONSTRUCTION ERECTING STEEL FOR MORRISON HOTEL, CHICAGO

ft. The boom is built in the same way, but has 30-ft. end sections, making a maximum length of 100 ft. All the rigging is of ¾-in. wire rope. The hoisting capacity at maximum reach (about 90 ft.) is 15 tons. As used at the Morrison Hotel, the mast was 90 ft. high and the boom 80 ft. long. The hoisting capacity was 25 tons at the maximum reach of 70 ft. The derrick lines were operated by an electric hoist with 50-hp. motor.

The boom is about 20½x27 in. at its largest section, having two 26-in. side plates and 20-in. top and bottom plates, all $\frac{3}{16}$ in. thick. There are four corner angles, all 2½x2½x¼ in. The bottom angles are inclosed within the box, but the top angles have outside upstanding legs, as shown by the section. At intervals there are

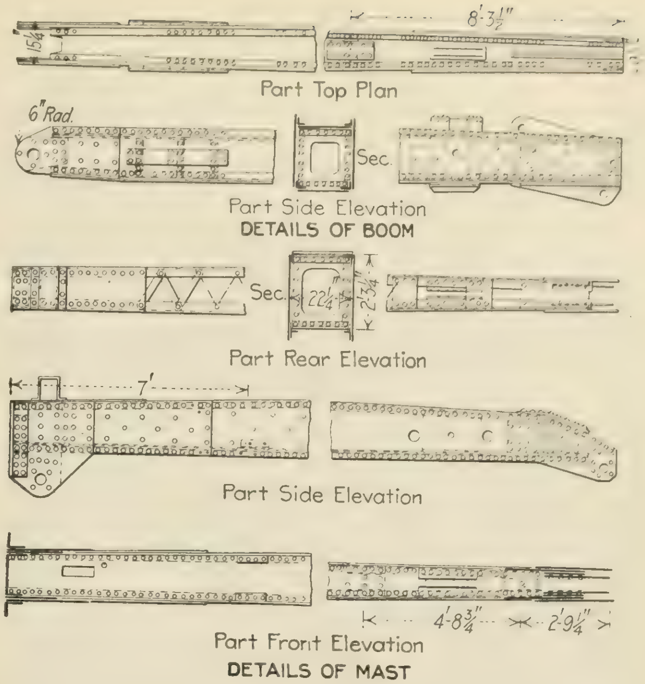


FIG. 3. DETAILS OF BOX-GIRDER BOOM AND MAST OF DERRICK

interior diaphragms, each consisting of a web plate (with large hole) and four angles that are riveted to the plates of the boom. The boom turns on a 4-in. shoe pin fitted to shoe plates on the mast and has a 22-in. sheave at the heel. To the head are attached two link-and-pin attachments for the blocks of the topping-lift and hoisting lines, and near the head is a 24-in. sheave for the hoisting line.

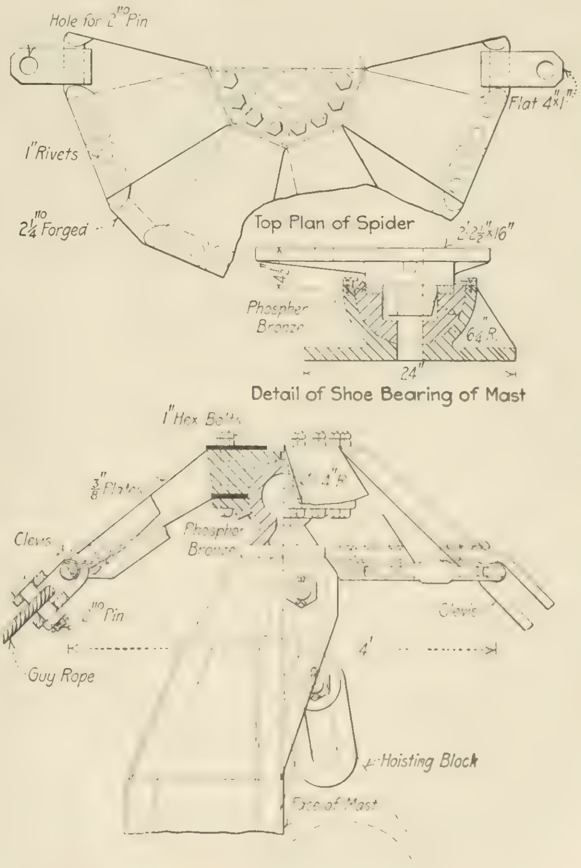


FIG. 4. SPIDER AND SHOE OF GUYED DERRICK

An important feature is that the boom can be raised to a vertical position, standing with its head against the mast. This is made practicable by extending the pin plates for block attachment at the head of the mast to carry the topping-lift attachment forward of the face, so that the topping lift hangs vertically in front of the mast when the boom is raised to its limit.

The mast is about $22\frac{3}{4}$x30 in. at its largest section. Unlike the boom it has one latticed, or open, side, this being the back. The two front angles (with outstanding legs) are the same as in the boom, but the rear angles are $3\frac{1}{2}$x3 in., with the lacing on the inside. The lacing is of bars $2\frac{1}{4}$x$\frac{3}{8}$ in. and $2\frac{1}{2}$x$\frac{1}{2}$ in., and angles $2\frac{1}{2}$x2x$\frac{1}{4}$ in. The front plate is 22x$\frac{1}{4}$ in., and the two side plates are 30x$\frac{1}{4}$ in. The diaphragms are each composed of a $\frac{3}{16}$-in. plate (with hole about 14x17 in.) and four angles. The mast has a $13\frac{1}{2}$-in. sheave at the base and two similar sheaves and a 16-in. sheave near the top. At the top also is a link-and-pin attachment for the block of the topping lift.

The spider at the head of the mast is of unusual construction and is shown in Fig. 4. It consists of two dished plates cut to form eight radial arms, with narrow spaces between. The plates are riveted together at their outer edges, with fillers between them. Each filler extends across one of the open spaces and has this portion rounded to receive a U-shaped clevis for the attachment of a guy line. At the center of the spider is a casting with hemispherical bearing on a 4-in. ball riveted upon the top of the mast.

The base of the mast has a casting with a hemispherical bearing of $6\frac{1}{4}$-in. radius in a cast-steel shoe. To the shoe is attached a bull-wheel 7 ft. in diameter, having its rim made on a 5-in. channel with web inward. This is carried by two horizontal members riveted against the mast, each consisting of an inverted 5-in. channel with an angle 3x$2\frac{1}{2}$ in. riveted inside the web. Horizontal angle braces extend from these members to the circular channel, and diagonal braces in a vertical plane extend from this channel to the sides of the mast. On the back of the mast is a loop to carry a cross-timber for swinging the derrick by hand.

FINE AGGREGATE

The Short Method of Calculating Areas given by C. K. Averill in "Engineering News," Dec. 21, 1916, p. 1186, is not of general application to three- and four-sided areas. It should have been so stated, although a glance at the demonstration given makes it apparent that the method will not hold for four-sided figures containing a reëntrant angle; and as Prof. E. F. Chandler (University of North Dakota) has pointed out, it is true only if in traversing the perimeter of the figure no two sides run forward in directions that are in the same quadrant. The method is correct only in the special case illustrated, of a figure of such shape that each side cuts off a complete triangle from the inclosing rectangle formed with the sum of the departures and the sum of the latitudes of the given figure as its base and altitude. In this case the method is very convenient.

An Electrolysis Survey of the entire distribution system of the Boston Metropolitan Water and Sewerage Board was made during the latter part of 1915. As in former years, the results show differences of electric potential and electric currents of considerable magnitude resulting from the operations of the electric railways. No excavations were made in conjunction with these measurements to determine the extent of the electrolytic corrosion of the pipes, but the policy has been continued of installing wooden insulating joints about 500 ft. apart on all new pipe lines to prevent the accumulation of large electric currents on the pipes. None of the water mains has been recently destroyed. The city has detailed a man to make tests at certain stations where current is known to be flowing and to gather other data in regard to this work. There has been no known damage to the city water mains for some years, but services are occasionally destroyed, mainly in Dorchester and Roxbury. The telephone company and the lighting company have had no trouble of a serious nature on cables within the past five years; each makes frequent or regular tests, and cables are bonded to railway returns. The traction company has a regular detailed force for making tests and examinations of trouble and damage reported to subsurface structures; such surveys as are made have the coöperation of the telephone company. Information from the several sources indicates that recent electrolytic damage has been slight, but the tests and the measures taken to prevent trouble evidence the presence of stray electric current in the ground.—Report of the National Board of Fire Underwriters, December, 1916.

A Big Coral Boulder scooped up by a dredge in the Hawaiian Islands is shown in the dredge bucket in the accompanying view. The boulder was so large that it could not

BIG CORAL BOULDER IN DREDGE BUCKET

be gotten through an opening 9x14 ft. This material weighs about 2,700 lb. per cu.yd.

Patching Concrete Pavement, at Charlotte, N. C., is accomplished with an outfit which includes a Hooke portable asphalt plant, having a capacity of 21 cu.ft. to a batch, one wagon and team, three laborers and the necessary tools and appliances. The asphalt mixture used in making the patches is composed of 75% sand, 10% portland cement and 15% asphalt. This is richer in asphalt than the ordinary sheet-asphalt paving mixture. Before making a patch, the concrete around the edge of the hole was trimmed back to a firm, unbroken surface. The walls or sides of the hole were made vertical and excavated to a depth of about 3 in. The hole was then thoroughly cleaned out, and the sides and bottom were painted with melted asphalt. The sheet-asphalt mixture, heated to about 300° F., was then deposited, compressed by tamping, finished with a hot smoother and dusted over with cement. In every place the asphalt patch has remained intact, showing no signs of spreading or giving way. New holes have been worn in the concrete pavement at other places, in the meantime. The asphalt plant was conveniently located on other work, so that no time was lost in firing up or moving. There was no waste in having surface material left over. The area covered by patches was 4.54 sq.yd., and the unit cost was 63c. per sq.yd.

Editorials

Uniting the People of the United States

History has been made very rapidly since the last issue of *Engineering News* went to its readers. The Government of the United States and its people have been confronted with the necessity of making prompt and wise decisions in one of the most momentous situations that has ever confronted the nation. There have been deep and broad differences of opinion here on matters connected with the war and on other matters that have seemed to gravely threaten our national welfare. In the responsibility now confronting us these differences have all but disappeared. Almost with one voice men of all parties and all factions have avowed the determination to stand by the President in any step he may take for the defense of American rights. A remarkable illustration of this occurred at the Republican Club in New York City on Feb. 3. The Chairman of the Club declared that partisan politics stop at the water's edge. Elisha Lee, representing the associated railways of the United States in their dealings with the railway brotherhoods, and W. S. Stone, Chief of the Brotherhood of Locomotive Engineers, declared at this time of national stress the railways and their employees will find ways to settle their differences without interrupting the country's business.

In no calling or occupation will a more universal spirit of loyal patriotism be found than among the men of the engineering profession. A very large proportion of them have been actively interested in plans for developing true preparedness in the nation, through the great inventory of American factory plants and through other means. In the present national emergency the Government can count on the whole-hearted support of the engineers of the United States, and that their services are greatly needed in many departments of the nation's work there is no room for doubt.

Engineers Protest Against Electric Drive for Battle Cruisers

A strong body of expert opinion is opposing the decision of the United States Navy Department to adopt the electric drive on the four new battle cruisers for which the Government is now seeking to let contracts. These vessels are designed to be the largest and fastest first-class warships ever built. Each of them is to have boilers and engines capable of developing 180,000 hp. The Department proposes to equip these vessels with the electric-drive system, the plans involving steam turbines driving four electric generators, each of 45,000-hp. capacity. These furnish current to eight electric motors mounted directly on the propeller shafts.

When the bids were submitted for these cruisers, the Fore River Ship and Engine Co., whose President, J. W. Powell, was formerly a United States naval constructor, offered to build the vessels at a much lower figure, provided geared turbines were substituted for the electric drive. It was pointed out that among other objectionable features of the department's design is the location of about half the boilers in the vessel above the protective deck, where they would be liable to penetration in case the vessel was in action.

Dr. Schuyler S. Wheeler, President of the Crocker-Wheeler Electric Co., in a letter which was published in the New York *Sun* of Jan. 29, severely criticizes the Navy Department for its adoption of the electric drive on these important vessels, without obtaining independent expert opinion in the matter. Dr. Wheeler says:

> These huge electrical machines, carrying enormous currents of electricity, with their cables, rheostats, switches and switchboards, and other complicated electrical apparatus, bulky and at the same time delicate, likely to be short-circuited, cut by splinters or otherwise, and in many other ways put out of service, are a new and almost wholly untried experiment. No other country is using electric drive for warships.

Dr. Wheeler urges with great force that Congress should not approve this huge experiment by the Navy Department until it has been investigated by a board of independent engineers, competent to advise on the technical questions involved. It appears that the Naval Consulting Board, which is now an official body, has not been asked to express an opinion at all in the matter and that the whole big experiment, involving vessels which will cost probably over $80,000,000 and will take presumably over four years to construct, has been handled apparently as a mere routine matter by the officers of the Bureau of Steam Engineering.

With all due respect to these officers, it is a fact which hardly permits dispute that they have not had the breadth of experience in the use of electric machinery of the largest size that would make them competent to pass upon such a technical question. Dr. Wheeler is one of the pioneers in the electrical industry, a past-president of the American Institute of Electrical Engineers, and his protest obviously is one that cannot possibly be lightly passed over.

Secretary Daniels is now appealing to Congress for several million dollars' additional appropriation to enable the contracts for these vessels to be let. A large part of this additional cost is unquestionably due to the adoption of the electric drive.

These are times when the Government and all its officials must seek by every means to retain public confidence. Engineers, who can fully appreciate the great responsibilities and difficult tasks that the members of the profession in high Government positions have to carry, have no desire to criticize needlessly. They are fully aware, however, that grave mistakes have been made in the past in many matters of Government administration in which their own profession is involved; and in this period of national crisis it is surely proper to urge that the engineers of the army and navy should not fail to avail themselves of the expert knowledge of civilian engineers.

Building Well and Operating Poorly

Spending money unstintedly for construction, often under the supervision of the best engineers the country affords, and then being niggardly in maintenance and operation appropriations and leaving costly and perhaps complicated works to run themselves except for political heelers or lame ducks is the rule rather than the exception in many if not most American cities.

The foregoing reflection is prompted by the following sentences from the annual report of the Connecticut State Board of Health for the year ended Sept. 30, 1916 ("Monthly Bulletin," Connecticut State Board of Health for January; Hartford, Conn.):

> Large sums have been expended by municipalities and towns installing works for the treatment of sewage which might just as well have never been expended, because, for the lack of skilled supervision and intelligent operation, the results, as far as conserving the purity of our streams, have been negligible. When we realize that out of sixteen municipal and town sewage-treatment plants in the state but three are disposing of sewage satisfactorily, immediate action should be forthcoming.

That Connecticut is not alone in this matter is of course no reason why her legislators should not give her State Board of Health the control over sewage-treatment works that it pleads for in the report mentioned. The legislature recently put new responsibilities upon the board as regards "sewage disposal, stream pollution and watersheds," but provided no funds with which to perform those responsibilities—a characteristic legislative habit. Some advance has been made in health legislation, and Governor Holcomb, in his inaugural message, advocated a reorganization of the State Board of Health and an appropriation for its work "sufficient to give our state a health administration adequate for modern needs." The engineers of Connecticut should do their part to induce the legislature to carry out the recommendations of the governor.

Engineers as Publicity Experts

The work done by a committee of the Engineering Association of the South in bringing to the attention of President Wilson and of Congress the advantages of Muscle Shoals as a site for the Government's nitrate plant was briefly recorded in a recent issue; but the achievement deserves something more than passing notice, for it demonstrates what engineers may accomplish in a field which has been often held to be no proper part of the engineer's work—the field of publicity.

The work of publicity is generally associated in the mind with the advertising of goods for sale; but that is only a part of what publicity includes. Publicity may be broadly defined as the systematic influencing of men's minds on a large scale toward a definite end.

Most engineering works of the present day must have a prepared foundation of publicity before a beginning can be made in the work of construction. It is too often assumed that this publicity work is no part of the engineer's business; but as a matter of fact, if he does not at least aid in it by furnishing facts and figures, there are likely to be serious flaws in the foundation.

It is common to hear engineers complain because the public awards the honor for a great engineering work to the promoter and not to the engineer who does the technical part of the work. But the public discerns what the engineer often fails to see, that the work of overcoming the inertia of men's minds is often a more difficult task than the work of shaping steel and earth and rock, which the engineers accomplish. There are a score of great engineering enterprises in the United States today which are known to be practicable and profitable, but whose realization depends on the coming forward of the genius who will persuade men's minds that the thing can and should be done and show them the way to do it.

The promoter is the man who sells the engineer's services. The engineers who have achieved widest fame and largest fortune have been those who have discerned this and who have been able by promoting their own enterprises to fix their own rates of compensation.

There is no lack of illustrations to show that engineers from the earliest days have been able to succeed in the work of publicity. The Stephensons, famous among the pioneer railway builders of England and the Continent, were chiefly occupied, not with the technical problems of actual construction, but with the task of convincing the investing public and parliamentary committees of the merit of their enterprises. Captain Eads, the builder of the St. Louis bridge and the Mississippi jetties, is remembered by the public because of the publicity which he secured for his great enterprises.

These are examples from great and well-known works, but there are countless examples among the smaller enterprises where engineers have themselves done the foundation work publicity and reaped the reward. The work done by the engineers of Nashville and vicinity to demonstrate the advantages of the Muscle Shoals site is notable because it has been done as a free contribution to the public welfare, something which has been much talked about as the duty of the engineering profession but of which no great amount has been actually accomplished. It is also notable because it is a remarkable illustration of efficient publicity work. The booklet which these engineers produced was carefully planned to arouse the interest of the recipient at the start and to hold his interest until he comprehended the main facts, at least, which it was the aim to impress upon his mind.

Commission-Manager Plan of Vital Interest to Engineers

The keenly intelligent analysis of municipal administration now going on throughout the country is bound to react favorably upon the status of engineers. Particularly encouraging is the rapid progress of the commission-manager plan.

The commission plan alone is a marked advance on earlier forms of municipal government as they have worked in the United States, but the plain commission system has elements of great weakness. Some of these have been pointed out more than once in these columns, but they affect the engineer so vitally that they will bear repetition—all the more when it is possible to present a fresh statement from a new source which at the same time illustrates the widespread keen intelligent interest in municipal affairs already mentioned.

Speaking on opportunities for increased municipal efficiency before the Helena Commercial Club on Jan. 24, Henry Gerharz, United States Surveyor General for Montana, reviewed the growth of the commission and

commission-manager plans of city government. He quoted with approval sentiments expressed editorially by the St. Paul *Pioneer Press* of Jan. 14, 1917, after experience with the commission plan in that city. That journal declared that while "widespread experience approves and justifies the system in most of its essential principles," yet it is agreed by students of the plan that some lacking element "has operated to prevent the fullest results rather than condemn the system." This lack, the *Pioneer Press* believes, is met by adding the city manager, "so the city's affairs are conducted exactly as are the affairs of a large business concern."

Mr. Gerharz's own concise and apt summing up of the fundamental principles that make the commission-manager plan superior to the commission plan is as follows:

The people (stockholders) elect a commission (board of directors) who hire a city manager (general manager) who appoints and directs the employees. This plan gives a strong single-headed executive presiding over all departments, coordinating their activities and acting as a court of appeal in case of friction or rivalry between the different departments.

The people can select, as commissioners, representatives who will truly represent their class or walk of life without being hampered by any thoughts of his business experience or salary-earning capacity. These representatives can act more intelligently through a manager than if they were individually compelled to assume the direction of a department. Membership in the commission becomes attractive to the ablest citizens, since it offers an opportunity for great usefulness without interrupting their private careers or business.

It would be difficult to give better expression in reasonable compass of the essentials for securing a combination of representative government with efficient government. That an engineer has done this so admirably in the course of a luncheon address should be a comfort to those who bewail the silence of the engineer on public questions or, admitting that he speaks now and then, deny his ability to speak well.

Do any of our readers ask why the engineer, as such, is vitally concerned in the adoption of the more efficient of the two forms of government? If so, the reply is that under the straight-commission plan the heads of administrative departments become such by either the chance of popular vote or else on agreed division of duties among the commissioners themselves after election. These commissioners soon feel themselves qualified as "experts" in the various matters under their control. As their importance grows upon them, they relegate technical and professional men to the rear. Under the commission-manager plan the manager selects all department heads. If he is not himself a professional man, the chances are that he appreciates the value of such men and is willing to pay them accordingly.

Finally, many of the city managers, including those of greatest achievement, are engineers. This will probably continue to be the case for some years. This is one reason, even if not the most notable, why the commission-manager plan vitally concerns engineers.

Shall the Work of Railway Valuation Be Left Incomplete?

For nearly four years an army of engineers has been engaged in making an accurate valuation of the entire railway system of the United States. The work has been done under the terms of a law enacted by Congress in 1913, and it has been the universal belief of the public, and doubtless of the engineers engaged in this work, that the final result would be an authoritative determination of the value of the different railways.

Now comes the surprising announcement, made by Director C. A. Prouty in a hearing before the Interstate Commerce Commission last week, that it is not the present intention of the commission to make any final determinations of valuation. What the commission intends to do, apparently, is to announce the detail results of the inventory that it has made, in the same manner as in the case of the two Southern roads, the Texas Midland and the Atlanta, Birmingham & Atlantic, for which the tentative results were announced some two months ago.

It must be said frankly that there is some support for this attitude of the commission in the phraseology of the law enacted by Congress in 1913. That law, as was pointed out in this journal at the time (*Engineering News,* Nov. 9, 1913), required the commission to ascertain for each railway the cost of reproduction new, the cost of reproduction less depreciation, and also the original cost of lands, rights-of-way, etc., used, and the amount of gifts, bonuses, etc., received by the company; but the law did not indicate what use, if any, was to be made of these diverse elements, although Section 5 of the law says that the commission "shall show the value of the property of every common carrier as a whole," the term "value" being popularly understood to mean what it would cost at the present time to replace the property in its present condition. The work of the commission in valuing the country's railways will unquestionably fall far short of the full measure of public expectation if the commission fails to make a final determination of that value in a form intelligible to the public. The separate figures of inventory which it has compiled do indeed furnish the data from which such a valuation could be made; but the public has for years been looking to the commission as the authority for fixing earning and acquisition bases, and the public would rather have its judgment as to what shall or shall not be included in the final valuations than it would the opinion of Congress.

It may be freely admitted that these figures of value, when determined, could only rarely be of use in settling disputed rate questions, or even in fixing assessments for taxation. There are many thousands of miles of railway in the United States which are unable to charge rates high enough to enable them to earn even a very modest rate of interest on their valuation as measured by cost of reproduction, not because of any public rate regulation, but because competition and other commercial conditions make it impossible for them to charge such rates. Again in assessment for taxation, unless railways are to be taxed on a different basis from all other property, the only fair basis of taxation is earning power.

Those who have looked forward optimistically to an era of better relations between the railways and the public had hoped that the valuation by the Interstate Commerce Commission might put finally at rest all controversy as to whether the railways are attempting to earn dividends on watered stock at the present time. If the commission refuses to exercise the authority that Congress almost certainly intended to confer upon it and fails to make a final valuation of the railway property of the country, a large part of the benefit that ought to result from the vast task on which so many engineers have been engaged will be forfeited.

Letters to the Editor

Is Tension Positive or Negative?

Sir—A number of years ago the writer believed it to be a well-established custom to give the compression the plus and tension the minus sign on stress sheets of bridges. It now appears that many, if not most, of the recent graduates have been taught the opposite. It is unfortunate that confusion exists regarding this sign conventionality.

The pressure of a bridge pier on its foundation (a compressive stress) has the positive sign. The pressure of a bridge shoe on masonry is considered positive. The bearing power of a pile is positive. The pressures of liquids and gases in pipes are considered positive. Barometer pressures are positive. Earth pressures against retaining walls are positive.

If engineering science is viewed as a whole, it would appear that compression should be called plus and tension minus on a bridge stress sheet in order to be consistent with established practice in foundation design, masonry design and earth-pressure and fluid-pressure calculations.

Los Angeles, Calif. R. W. STEWART.

[An extended editorial discussion of this question was given in the Engineering Literature Supplement to "Engineering News" of Dec. 15, 1904, p. 549. The arguments are essentially: (1) Compressive stress (not presssure) should be positive because it is the predominating stress in all structures that carry load downward to a support. (2) Tension should be positive because it corresponds to stretch, or increase of length, so that with the positive sign Hooke's law for tension holds without an arbitrary minus sign. Formerly, the practice of making compressive stress positive was widespread, but in the past 15 or 20 years the tendency has been in the contrary direction.—Editor.]

Difficulties in Flood-Frequency Studies

Sir—The article relating to fixing maximum flood limits in the Miami Valley flood-protection work, published in your issue of Jan. 4, 1917, presents a very comprehensive investigation of storm occurrence in the eastern United States, for which those who conceived and carried it out deserve much credit. The investigation was made in such a new field and involved the collection of such a large mass of valuable data relating to storms that the writer believes it will be of particularly great benefit, not only to civil engineering, but to meteorologic science, if these data can be published.

The method employed for determining storm frequencies, although so well adapted to the problem, has also certain inherent limitations that should be kept in mind for a proper understanding of the results. The fundamental idea of the frequency studies is stated to be that the storm experience of one station or one quadrangle adds to that of others. In this way, it is asserted, storm incidence for very long periods of time could be studied, though the records were short-time.

The lengths of records at the 478 stations in the central basin are said to have varied from 10 to 73 years, and averaged 15.8 years. It appears, therefore, that the great majority of the records were obtained in the last 20 years. There seems to be considerable evidence that the climate has changed noticeably within the past few centuries,[1] such changes being accompanied by increase or decrease in storm occurrence. There are also those who maintain that there has been a tendency for floods to increase in the Ohio Valley in recent years;[2] and it is by no means established that if there is such a tendency it may not be due, at least in a measure, to changes in the occurrence of storms. Therefore, the storm-frequency characteristics that cover the experience chiefly of the past 20 years may be considerably different from what they would be for a 100-year period, and perhaps very appreciably different from what they would be for a 1000-year period. Because these results may be based too exclusively on the conditions of the past 20 years, a similar investigation confined to the records of longer duration would be instructive.

[1]Discussion by E. Huntington, "Journal" of the American Water-Works Association, Vol. 3, No. 1, p. 94.

[2]"Floods," M. O. Leighton, United States Geological Survey Water-Supply Paper No. 234, pp. 10-27.

According to the writer's understanding, the mode of procedure described as method A would give the expected frequency of occurrence of storms of different magnitudes at one observation station; method B would give the average intensity of storms of such magnitude that they occur not oftener than once in 50 years or not oftener than once in 100 years at one observation station, and not the intensity of the storm whose average period of recurrence is 50 years or 100 years, as assumed in the article. The two ideas are quite different. Either method, it should be further emphasized, gives results applying to but one observation station and not results applying primarily to areas as large as the entire Miami basin, as is maintained in the article. This is true because the method only takes account of the total number of times a certain precipitation has occurred at certain separate stations and does not take any account of the probable frequency of the storm as affected by the area covered by it. It is stated that 35% or approximately 1225 of the storms considered covered from two to six stations, and that 15% or approximately 525 of the storms considered covered over six stations. This indicates what would naturally be expected, that the probability of a storm would decrease as the number of stations it covers is increased. So it seems to the writer that the frequency of occurrence of a certain storm over the entire Miami basin would probably be much less than the results indicated by the curves. The saving condition is that the error is on the safe side.

Furthermore, studies of the writer have impressed upon him the extreme variability of the intervals between unusual meteorologic phenomena, such as very severe storms. For example, a drought of a certain degree of intensity, which would appear to have an average frequency of about once in 40 years, may occur at intervals of any length from five years up to at least 80 years. Those storms of which the average frequency was 500 years would be expected to occur at intervals anywhere between the limits of, say, 50 and 3000 years. The records of stations in the central basin aggregate about 7550 years. Even if a 7500-year record were available at one station, it would be far too short for determining with any degree of accuracy the frequency of storms occurring at such widely varying intervals as the 500-year storm. The saving condition in this case is that storms might vary considerably in frequency from the 500-year storm and not vary very widely from it in amount, so that so far as this factor is involved the amount computed for the 500-year storm would probably not be far from correct.

It is probably quite generally accepted that the longer the record of storms the greater will be the severity of the worst storm recorded. The 1913 Ohio Valley storm was very unusual, whether it was such a storm as will occur once in 50 years on an average or once in 1000 years. By basing the flood limit on a storm 40% greater than the 1913 storm, Fuller's formula,[3] which makes the maximum flood flow vary as $1 + 0.8 \log T$, where T is time in years, would make a storm 40% greater than a storm occurring once in 50 years a storm such as would occur once in 700 or 800 years, while a corresponding increase in the 1000-year storm would make it such as would occur about once in 50,000 years. Likewise, a statistical analysis of storm frequencies indicates very conclusively that a storm so much greater than that which occurred in 1913 is for all practical considerations outside the realm of probability.

The writer believes that the frequency curves present in concise form the tendencies in the variation in frequency of storms of different magnitude at one observation station, but that as representing actual frequencies as they would be obtained from records over very long periods of time there is a possibility that they may be appreciably in error; at least, it cannot be satisfactorily demonstrated that they are not. Furthermore, it is believed that they present results which are probably over-conservative for application to areas of the size of the Miami basin. The large "factor of ignorance," which is certainly wisely introduced in a problem of this kind, dispels all possible doubt as to the conservatism of the assumption as to the maximum flood limit. R. W. DAVENPORT,

Assistant Engineer, United States Geological Survey.

Washington, D. C., Jan. 17, 1917

[3]"Flood Flows," Weston E. Fuller, Mem. Am. Soc. C. E., "Transactions," Am. Soc. C. E., Vol. 77, pp. 564-694.

Activated Sludge at San Marcos, Tex.

By Henry E. Elrod*

In regular daily service in San Marcos, Tex., there is a practical and highly satisfactory activated-sludge sewage-disposal plant having a capacity for treating 150,000 gal. of domestic sewage per 24 hr. The plant was designed and built by Ashley F. Wilson, engineer-manager for the San Marcos Utilities Co., and has been in operation since about Sept. 1, 1916.

The plant (the general arrangement of which is shown in Fig. 1) consists of an aëration tank 16 ft. wide by 40 ft. long and about 8½ ft. deep from the flow line of the sewage to the top of the filtros plates. The tank is divided into four channels, each channel having a row of filtros plates 12 in. square at the apex of inverted pyramids down its center. The filtros plates are spaced 3 ft. c. to c., there being 52 plates all told. The opposite end of each channel is open, thus allowing the sewage to flow in series from the inlet at the left to the outlet at the right. The outlet opens into the settling tank, which is 10 ft. wide by 25 ft. long and 25 ft. deep, the walls having a vertical batter of 1 to 2.

Aëration is accomplished by means of a 6x10-in. Connersville blower of the Boston type, having a rated capacity for 260 cu.ft. of free air per minute under 5 lb. pressure. It is actuated by an electric motor requiring an average of 4 kw. of current. The sludge lift is operated by air from this blower.

When the plant was first put into operation, the distribution of air through the filtros plates was uniform and satisfactory. Later, however, some of the plates showed signs of erratic action. Upon investigation it

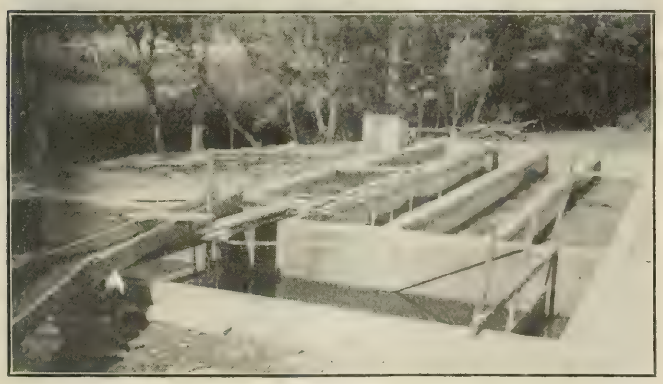


FIG. 1. GENERAL VIEW OF ACTIVATED-SLUDGE PLANT, SAN MARCOS, TEX.

was found that one corner of one plate had been cut out by the action of the air and the other plates had become choked to such an extent that their usefulness was destroyed. As each plate failed, a small pipe with its lower end open and the upper end connected to an air line was substituted with satisfactory results. Fig. 2 shows a channel with five (only four show in the photograph) such pipes in operation. Fig. 3 shows a channel with all the filtros plates operating satisfactorily. It will be noticed that there is no material difference in the ebullition at the surface of the sewage between the two channels. In the right-hand channel (Fig. 3) it will be noticed that, just under the board across the tops of the channel walls, the sewage is boiling up at a fierce rate. It is evident that the filtros plate below has failed.

*Engineer, Interurban Building, Dallas, Tex.

FIGS. 2 AND 3. PIPE DIFFUSERS AT LEFT AND FILTROS DIFFUSERS AT RIGHT

The effluent produced by the plant has a relative stability of 99%, a bacterial reduction of about 98% and is bright and sparkling, though slightly tinged with green, supposedly on account of the algæ in the municipal water-supply. The activated sludge produced is of a golden-brown color. Although the plant has been in operation for more than three months, there has been no appreciable accumulation of sludge other than that necessary to operate the plant.

The total cost of the completed plant, in round figures, was $3500, which sum included the lowering of the bottom of the settling tank after the plant had been in operation for a short time. The plant is near the city, but it produces no offense watever. The operation of the plant is simple—it requires but a few minutes' attention each morning.

Excelsior Filters in the Water-Softening Plant at Owensboro, Ky., do not appear to be giving the satisfaction previously reported or else the plant is otherwise at fault, for considerable trouble is being experienced with lime deposits in the water mains and meters. The softening plant was put in use in December, 1911. (For description see "Proceedings," American Water-Works Association for 1912, pp. 203-218, a paper by E. H. Breidenbach, then and now superintendent of water-works.) After treatment with lime and soda the water is discharged downward from a central mixing tower into the bottom of a sedimentation tank. The tank bottom slopes upward from the lower to the outer sides of the tank, where the water passes through a channel on either side filled with excelsior. This material is designed to remove such suspended insoluble matter as is not deposited by sedimentation.

Motor-Driven Street-Cleaning Equipment is growing popular in Baltimore, Md. Three additional electric tractors were purchased last year by the Street-Cleaning Department for the squeegee machines, making a total of nine motor-driven squeegees at the present time Experience in this and other cities has shown these machines to be an efficient and economical way of cleaning smooth pavements, particularly in view of the increased cost of manual labor sufficient to clean the ever-increasing area of improved pavements being laid. In this connection the Street-Cleaning Commissioner reports that provision for an increase of 25c. per day in the pay of all laborers in his department has been made in the appropriation for the year 1917, making a total increase of $64,000 for the year in this one item alone. On the most important heavy traffic thoroughfares the squeegees are used daily, weather conditions permitting; streets in residential sections are washed four times each week. This service, particularly during the hot summer months, renders the streets cool and reasonably dustless at all times.—Baltimore (official) "Municipal Journal," Jan. 12.

Dry Mixing of Concrete Materials on Calumet Sewer at Chicago

Second-Prize Concrete Dry-Mixing Article in the "Engineering News" Prize Contest

By Benjamin Wilk*

Dry mixing of concrete materials at a central mixing plant is well illustrated on section No. 6 of the Calumet intercepting sewer in Chicago, where Byrne Brothers, contractors, have been working an equipment consisting of elevated bins, bulk cement, mules, dump-cars and narrow-gage track, which they have developed after two seasons' operation of similar plants.

One-half mile of this two-mile section of 17-ft. 6-in. concrete sewer is practically completed. All the concrete has been assembled dry at a single plant, which on account of the arrangement of the railroad tracks was located near the end of the sewer at 123rd St. and Prairie Ave., just west of the Illinois Central R.R. tracks, and transported to a traveling mixer alongside the sewer trench.

A special unloading spur was built alongside the tracks, and from it the materials are handled. Elevated wooden bins are located parallel to the spur track at such a distance away that a crane can operate advantageously between the track and the bins, in unloading the sand and stone. These elevated bins (Fig. 1), built of 2-in. lumber and supported at 4-ft. intervals by 4x6-in. posts, are 6 ft. wide, 5 ft. high and about 275 ft. long, with the bottoms 5 ft. above the ground at one end and 6 ft. above at the other end, in order to allow for the passage of cars underneath. Partitions halfway up to the top are placed inside the bins at the 4-ft. intervals, so that in effect there are a series of bins each 4x6 ft. in horizontal cross-section and 5 ft. high. At the bottom of each of these sections there is a hopper arrangement, the opening and closing of which are controlled by a lever.

Mules, ½-yd. side-dumping steel cars formerly used by the French Government at the Panama Canal, and a narrow-gage 40-lb. rail track make up the transportation system. Passing tracks are conveniently located. Six cars drawn by a single mule constitute a train under normal weather conditions. For the haul of 2000 ft. now being made, four mules are required.

*Promotion Bureau, Universal Portland Cement Co., 210 South La Salle St., Chicago, Ill.

Crushed stone is first dropped into each car as it is pushed along by hand on the slightly inclined narrow-gage track under the bins. The sand is similarly dropped in by a man working the levers as the car moves along to the other end of the line of bins. It is then pushed about 75 ft. to a point alongside the railroad spur, where a car of bulk cement has been "spotted" (Fig. 2). Cement measured by a wooden box of 2½ cu.ft. capacity is carried out to a platform over the car and dumped into

FIG. 2. UNLOADING BULK CEMENT FROM FREIGHT CARS
Narrow-gage cars at left are filled wth cement, stone and sand; cement is being added to narrow-gage cars to right. All are to be pulled in one train to mixer

it. The car, with its load of stone, sand and cement, is then pushed a short distance past the cement platform; and when six cars are ready, they are coupled together behind a mule. On the journey to the mixer a siding has to be taken in order to allow returning empties to pass.

Within a definite distance from the machine the cars are uncoupled and pushed one at a time up to the mixer.

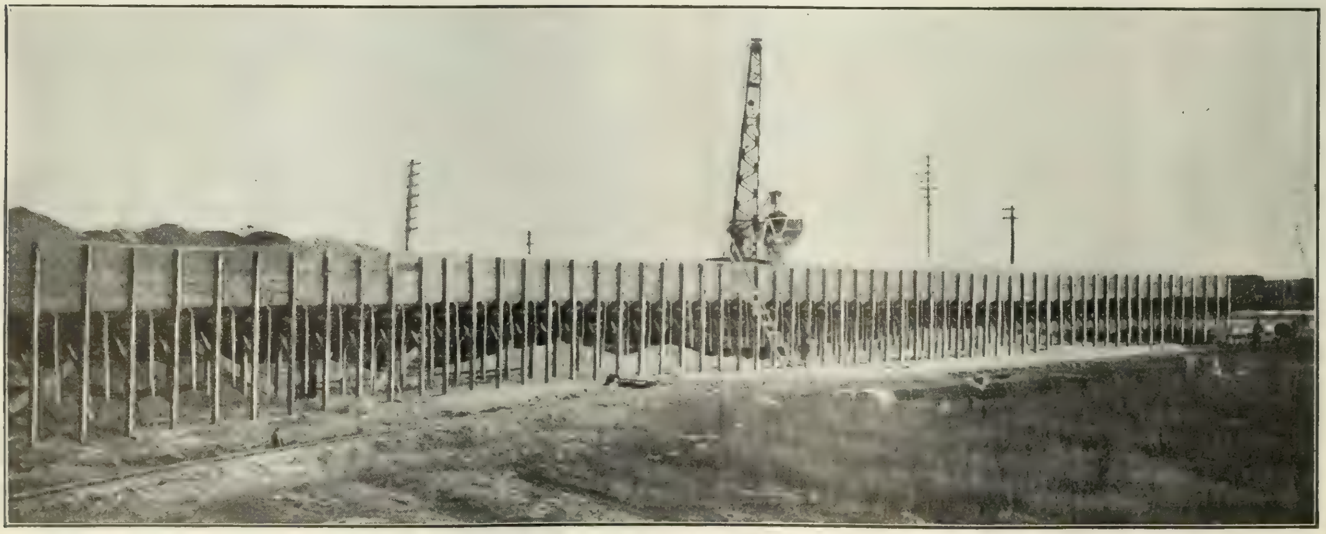


FIG. 1. UNLOADING STONE AND SAND INTO ELEVATED BINS FROM RAILROAD

FIG. 3. PLACING CONCRETE IN SEWER FROM MIXER TRAVELING ALONGSIDE TRENCH

Two men dump the car into the skip, by which the materials are raised into the drum. As it leaves the mixer, the concrete passes down through an adjustable chute into its place in the sewer. The chute is carried along directly by the mixer, which is self-propelling and moves along on a short piece of track (Fig. 3).

Handling concrete in this way, 400 cars a day are taken care of, which on an 8-hr. basis means 50 cars per hour, or a car practically every minute. That the mixer at this rate is working up to capacity is evident.

Dry mixing of concrete materials at a central plant, according to Mr. Kenna, the superintendent on the job, is much superior to and more economical than any other that has been tried out; and if the use of bulk cement had been considered in the original layout rather than made use of as an adaptation later on, the plan would be still more effective.

Analyzing the equipment, a means of planning similar jobs can be developed on a basis of one mule and driver and six cars to each 500 ft. of haul. At the loading end there are two men working levers and loading cars, one man pushing cars to the cement platform, one man making up the train. At the mixer there are two men on the mixer, two men dumping the cars, one man handling cars from the train.

Each job will naturally have to be considered separately in deciding as to the best layout for a central mixing plant. Among the points to be taken into consideration are nearness of railroad tracks, siding facilities, location of spur tracks, hauling distance, contractor's equipment, availability of various kinds of locomotion and character of the local surroundings.

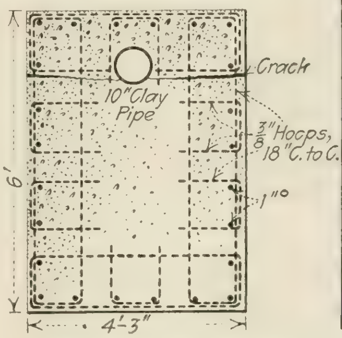
In sewer jobs similar to the one above described it has been found that a single location for a central mixing plant is economical if the plant is centrally located so that the haul at either end is no more than one mile.

The Foreign Trade of the United States in 1916 reached the enormous total of $7,873,000,000, made up of $5,481,000,000 in exports and $2,392,000,000 in imports. The exports exceeded by nearly two billion dollars the total for 1915 and by nearly three billion dollars the total for 1913. These figures surpass all previous records of foreign trade for this or any other nation.

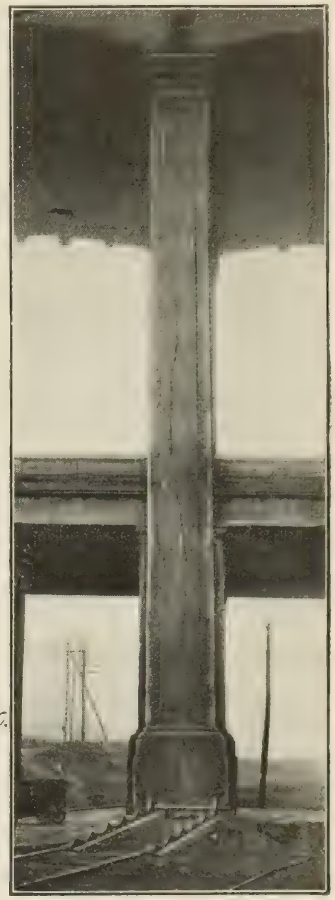
Concrete Column Cracks from Clogging of Embedded Drain Pipe

One of the tallest columns of the 12th St. double-deck reinforced-concrete viaduct in Kansas City, Mo., has been split from top to bottom of its 88 ft. of height by frost action, due to the stoppage of a drain pipe embedded in the interior. The damage was probably done following one of the late thaws last winter, but was not discovered until last fall, when the opening had become discolored and widened.

In building the viaduct four pairs of storm-water catchbasins were provided for the upper-deck 30-ft. roadway, which is 2200 ft. long and has a 5½% grade. Each of these catchbasins was connected with a 10-in. vitrified-clay sewer pipe that was embedded in the concrete of the nearest column. This pipe has two right-angled bends in the line at the top of the structure and another right-angled bend in the column footing, to allow it to pass out of the concrete to a connection with the city sewer. In the drain which caused the damage several pieces of form lumber and other débris had been allowed to drop into the pipe during the viaduct construction; these had lodged in the lower bend, stopping other fine material, until the lower 10 ft. of the vertical part of pipe was packed full. The first bend below the catchbasin was also stopped with street dirt. The freezing of the water that collected in the vertical section of the drainage line inside the column split it from top to bottom; in the upper part the cracks showed on the north and east faces, and in the lower part, where there are pilasters, on the north and south faces. The column was always in the shade.



SECTION OF COLUMN SHOWING CRACK



COLUMN CRACKED BY STOPPED DRAINPIPE

All interior drains are to be disconnected, and for a time, at least, all surface water is to be drained to the ends of the bridge. The split column will then be repaired by carefully pointing the cracks on the surface and, when this has set, filling the 10-in. clay drain pipe with a thick liquid cement grout, which by its own pressure is expected to flow into the cracks from the inside of the column and fill them out to the pointing.

News of the Engineering World

Unjust Burden on Ohio Engineers

The statutes of Ohio bearing upon the engagement of engineers on municipal improvements when the engineers do not reside in the city for which they are doing work were reviewed by W. J. Sherman, consulting engineer, Toledo, Ohio, in a paper read before the Ohio Engineering Society on Feb. 1, 1917. The paper made and commented on various citations from the statutes of Ohio. The author's summary may be quoted as follows:

(a) In the opinion of many solicitors he cannot be engaged at a fee in excess of $500 without a public advertisement and an award to the lowest and best bidder.

(b) A lawful contract cannot be entered into for his services unless it is certified that there is money in the fund not otherwise appropriated.

(c) That in many and perhaps most instances there is no money in the fund and cannot be until the bonds have been sold.

(d) That bonds cannot be sold until plans have been adopted and estimates approved.

(e) That the services of an engineer are required before the plans and estimates can be submitted.

(f) That even though money be in the fund when the service contract is executed it is likely to be transferred to the general fund at the end of the calendar year.

As a practical means of obtaining relief from these onerous conditions and of increasing the dignity of the profession Mr. Sherman suggested that the Ohio Engineering Society appoint a committee to investigate the whole subject and ask the coöperation of other engineering societies of the state to secure remedial legislative action.

Any City May Get Advice on Almost Any Subject for Yearly Fee

For a yearly fee of $100 to $950, according to population, any city in the United States up to those having a million inhabitants may obtain "special information and advice relative to practically any phase of city government which does not involve sending staff men into the field." Such is the announcement just made by the Bureau of Municipal Research, 261 Broadway, New York City, on behalf of its newly established "B.M.R Service." The $100 fee covers any city under 30,000 population. For larger cities the fees are: 30 to 50 thousand, $190; 50 to 75, $240; 75 to 125, $350; 125 to 250, $490; 250 to 500, $750; 500 thousand to a million, $950. The announcement states that cost accounts will be kept and that if they show the fees are too high the excess will be returned pro rata, or used for general service to all subscribers, as the latter may decide—the Bureau not being a profit-making institution.

From a long list of subjects on which the Bureau stands ready to give advice the following are chosen as of most interest to engineers:

Fire: What is the best type of motor apparatus for use in a city of 25,000 population, the streets of which are comparatively level?

Parks: Should park driveways be constructed and maintained by the park department or by the public works department, and why?

Garbage Collection and Disposal: Is it more economical to use motor apparatus in making garbage collections than to use horse-drawn apparatus?

Street and Road Construction: (1) What results have been obtained in other cities from the use of concrete pavements? (2) This city is considering the purchase of an asphalt repair plant. Have such plants proved to be good economy in other cities of this size?

Street Cleaning: What is the best method of cleaning business streets which have heavy automobile traffic?

Water Department: Should water meters be owned by the city or by the consumers, and why?

Included in the Public Works and Public Utilities staff of the Bureau are seven engineers, headed by Ernest P. Goodrich, recently consulting engineer to the Borough of Manhattan, New York City. Mr. Goodrich also heads the City Planning staff and is an assistant director of the Bureau. The director of the Bureau is Frederick A. Cleveland and the assistant director is Herbert R. Sands. Bulletins regarding the B.M.R. Service and the Bureau staff may be obtained from the Bureau at the address already given.

New York Increases Motor-Truck Fees

The schedule of fees for motor trucks adopted by the commission appointed by the legislature of New York last fall, has been made law, and went into effect Feb. 1. It is estimated that the new schedule will provide an increased revenue from motor-vehicle fees of $600,000, which will be equally divided beetween the state and the municipalities and be devoted to highway maintenance. The two public hearings of the commission were reported in *Engineering News*, Nov. 23, and Dec. 28, 1916..

The following is the new schedule of annual fees: For motor vehicles used as omnibuses for the transportation of passengers, $15 for five-passenger capacity or less, $24.50 for 6 to 7 passenger cars, $30.50 for 8 to 10, $43 for 11 to 16, $52 for 17 to 20, $55 for 21 to 22, $61.50 for 23 to 26, $67.50 for 27 to 30 passenger cars and $2 for each passenger capacity of all cars of over 30-passenger. For motor trucks used for the transportation of goods, wares and merchandise the fees are: $10 for less than 2 tons combined weight and capacity and $5 for each extra ton of combined weight and capacity up to 14 tons, making $70 for a truck of this size. Above 14 tons the annual fee increases in $10 increments for each ton.

To Reclaim 300,000 Acres of Land in Northeastern Arkansas

Plans have been drawn by the Morgan Engineering Co., Memphis, Tenn., for a drainage project to cost $3,000,000, the object being to reclaim 300,000 acres of land in Mississippi, Craighead and Poinsett Counties, Arkansas. This project provides for the construction of 300 mi. of ditch and 54 mi. of levees, requiring the moving of 30,000,000 cu.yd. of earth. This is claimed to be the second largest drainage district in the United States.

The control of floods along the Little River constitutes the most important and expensive part of the reclamation work. One section of the flood channel is to consist of a ditch 5 mi. long, 280 ft. wide at the base and 18 ft. deep. One unusual feature of the project is the draining of 20,000 acres through a three-barrel reinforced-concrete culvert under the main floodway. This land is lower than can be drained by the principal ditches and the culvert system is designed to save the cost of pumping.

The project will be split up into a number of contract sections and it is estimated that construction will require three years' time. The work of computing the assessments is now under way.

Famous Passaic Gas Case Abandoned

It has been announced that there will be no argument in the United States Supreme Court in the so-called Passaic Ninety-Cent Gas case, as an agreement by stipulation has been reached for dismissing the appeal of the Public Service Gas Co. from the decision of the New Jersey Court of Errors and Appeals. As noted at various times in *Engineering News* (Jan. 23, 1913, Dec. 24, 1914, Jan. 21, June 17 and July 1, 1915) the State Board of Public Utility Commissioners made a valuation of the company's property, in an action to reduce rates, and refused to allow an item of about a million dollars for franchise value. The company's appeals were fruitless in the state courts.

NOTES

Outfall Sewer Construction at Los Angeles, Calif., is being carried on with such funds as the city can secure pending a bond issue for all the works, including proposed Imhoff tanks, required to carry out the orders of the State Board of Health to lessen the pollution of the Pacific Ocean.

The New Colorado River Intake Gate for the main canal of the Imperial Irrigation District, will be built by M. D. Goodbody, of San Diego, Calif., late reports state, instead of by the Ross Construction, of Sacramento, Calif., as announced in "Engineering News" of Feb. 1, 1917. The contract price is given as $232,000. C. K. Clarke, Calexico, Calif., is chief engineer of the Imperial Irrigation District.

Damages for the Lower Otay Dam Failure in the sum of $122,500 have been asked in a suit brought against the City of San Diego, Calif., by the Western Salt Co. The company urges that its works on San Diego Bay were destroyed and a large quantity of salt and brine lost by the flood waters that followed the breaking of the dam. The plaintiff alleges that the dam was of poor design and that the city had long known that the structure was leaky and insecure.

Vehicle Tunnels under the Hudson River at New York City are being agitated by public authorities in New Jersey. The county authorities of Bergen and Hudson Counties are each ready to contribute $10,000 toward preliminary surveys to determine the feasibility and financial possibility of constructing such tunnels and it is reported that Essex County may shortly make a similar contribution. The work can then go forward in accordance with a state enabling act.

Bad Taste and Odor in the Cleveland Water-Supply the latter part of January led Mayor H. L. Davis to order Utilities Director T. S. Farrell to cut the amount of chlorine used for disinfecting the water from 10 to 7 lb. per 1,000,000 gal., although the health and water departments appear to think the larger amount is needed for safety. The City Council unanimously authorized its Committee on Health and Sanitation to investigate the chlorine situation. Council also called on the Director of Law to report where the responsibility for the character of the water-supply from a health viewpoint rests.

Land Reform in the State of Yucatan, Mexico, is being carried out by a commission, of which a civil engineer, Modesto C. Rolland, is the chairman. The object of the commission is to distribute the land among the native Indians and to carry out a revaluation of land properties for tax-assessment purposes. According to a published statement by Mr. Rolland, the land in Yucatan was formerly practically free of taxation. The total land taxes collected in the state amounted to only $50,000. The total valuation of lands was about $32,000,000. The commission has conducted a reappraisal, raising the valuation to $231,000,000, and from these lands the state is now receiving about $3,000,000 per annum in revenue.

New Park Lands by Dumping Refuse are proposed by the Chicago Plan Commission, which estimates that in 12 years 1300 acres of new land can be made in this way along the lake front of the south side of the city. The aggregate value of this land would be about $46,000,000. Nearly 40,000,000 cu.yd. of material would be required and the city would receive in cash about $3,000,000 for dumping privileges. The only initial expense would be for the construction of retaining walls. The present city dumps are nearly full and some new locations must be found away from the densely populated sections where the present dumps exist. The material for such dumping includes building wastes, excavated material, ashes, household rubbish and street sweepings. Filling of this kind has been used already for improvements along the lake shore in the north-side district of Chicago, and a water front park at Buffalo, N. Y., has been made in the same way.

New Westinghouse Center—Announcement has just been made by the Westinghouse Electric & Manufacturing Co. that the 500-acre plot of ground recently purchased at Essington, near Philadelphia, will form a new industrial center devoted to the production of large apparatus, the first group of buildings being for power machinery, principally steam turbines, condensers, and reduction gears. The initial development will cost in the neighborhood of $5,000,000 or $6,000,000 and will occupy about one-fifth of the area of the entire plot. The group will consist of two large machine shops, an erecting shop for heavy machinery, forge shop, pattern and pattern-storage shop, and power house. Work will begin on these as soon as satisfactory building contracts can be let. The site has a frontage of approximately 1 mi. on the Delaware River. Additional transportation facilities will be afforded by tracks from the Pennsylvania and the Philadelphia & Reading railroads. The number of employees is expected eventually to equal that at the East Pittsburgh center.

Enlargement of Railway Facilities at Baltimore, Md., at a cost of about $15,000,000, is provided for in plans submitted by officers of the Pennsylvania R.R. to Mayor Preston, of Baltimore, on Jan. 24. At present the four-track main line of the Pennsylvania R.R. from Philadelphia to Washington is reduced to two tracks through the City of Baltimore. The railway desires to secure two additional tracks through the city and proposes to parallel the present tunnel under Hoffman St. and the present Baltimore & Potomac tunnel under Wilson St. by two single-track tunnels. The yards at the Union Station are to be enlarged, and additional trackage and new freight sheds are to be built at the Calvert St. freight terminal. The reason for building the additional lines through the city as single-track tunnels instead of double-track is probably to secure better ventilation, since the movement of trains through a single-track tunnel of short length usually provides all necessary ventilation without artificial means. The work will require the closing of several streets, and ordinances providing for this and other necessary features in connection with the work have been introduced into the City Council. The city authorities are inclined to insist on electrification of the lines through the city before granting the permits for the work in question, but the Pennsylvania officials have heretofore gone on record as opposed to the adoption of electrification, since it would involve a very large and unnecessary expense and interfere seriously with the movement of through trains.

PERSONALS

J. W. Shiffman has been appointed City Electrician of Cleveland, Ohio.

E. C. Woodward, Assoc. M. Am. Soc. C. E., Engineer of Pavements, Dallas, Tex., has resigned.

John R. Slade, recently with the Wateree Power Co., Longtown, S. C., is now with the Braden Copper Co., at Rancagua, Chile.

Ralph N. Priest, formerly President of the W. E. Wark Co., has opened offices at 1737 Filbert St., Philadelphia, Penn., as Consulting Engineer.

C. B. Clegg has been appointed Acting Division Engineer of the Atchison, Topeka & Santa Fe Ry. at Clovis, N. M., succeeding J. W. Walter.

Dr. S. S. Goldwater, former Health Commissioner of New York City, has been appointed Consultant on Health and Hospitals, without salary.

Duncan Buie, of Richland Parish, has been appointed State Highway Engineer of Louisiana, succeeding W. E. Atkinson. The salary is $4000 per annum.

J. A. Nelson, M. Am. Soc. C. E., has resigned as Vice-President of the East Jersey Pipe Corporation, New York City, and for the present will take a vacation and rest.

E. P. Roberts, M. Am. Soc. M. E., Consulting Engineer, formerly Smoke Commissioner of Cleveland, Ohio, has been appointed Efficiency Engineer of the Philadelphia Rubber Works Co., Akron, Ohio.

J. A. Amyot, former Director of the Ontario Board of Health laboratories, Toronto, Ont., is now Sanitary Advisor, with the rank of Major, of the Canadian forces of the British Army in England.

C. E. Lehman has been appointed Engineer in Charge of the Third Engineering District of St. Louis County, Minnesota, at a salary of $2000 per annum, under R. W. Acton, County Engineer, Duluth, Minn.

Columbus K. Lassiter has been elected Vice-President in charge of manufacture of the American Locomotive Co., Schenectady, N. Y. **Harry B. Hunt** is Assistant Vice-President in charge of manufacture.

R. J. Rich has been appointed Engineer in Charge of the Second Engineering District of St. Louis County, Minnesota, at a salary of $2000 per annum, under R. W. Acton, County Engineer, Duluth, Minn.

H. H. Magdsick, an electrical engineer of the National Lamp Works, Cleveland, Ohio, has been given a gold medal for his work in supervising the lighting of the Statue of Liberty, New York Harbor.

H. J. Moore, recently Division Engineer of the Atchison, Topeka & Santa Fe Ry., Arkansas City, Kan., has been promoted to be General Inspector of Transportation, Eastern Lines, with office at Newton, Kan.

T. T. Harrison has been appointed Engineer in Charge of the First Engineering District, St. Louis County, Minneapolis, under R. W. Acton, County Engineer, Duluth, Minn. The salary of this position is $2000 per annum.

C. M. Upham, Assoc. M. Am. Soc. C. E., recently Chief Engineer of the Bureau of Inspection of the Coleman du Pont Road, Inc., has been appointed County Engineer of Sussex County, with headquarters at Georgetown, Del.

Henry Cummings, formerly Resident Manager of Wells Brothers Co., Building Contractors, Boston, Mass., has opened offices in the Unity Bldg., Boston, for private practice. The Wells Brothers Co. has retired from the Boston territory.

Robert H. Young, of Louisville, Ky., has been appointed Engineer in charge of McCracken County road work, with headquarters at Paducah, Ky. Bonds have been issued to the amount of $200,000 for improving the roads of this county.

Frederick J. Herring, of Little Rock, Ark., and **Harrison Schellhouse,** of Chicago, Ill., have formed a partnership under the name of Herring & Schellhouse, Civil Engineers, Forest City, Ark. Both are graduates in civil engineering of Purdue University.

Louis Yager, Division Engineer of the Northern Pacific Ry. at St. Paul, Minn., has been promoted to be Acting Engineer of Maintenance-of-Way of the lines east of Paradise, Mont., with office at St. Paul. **Bernard Blum** succeeds him as Acting Division Engineer at St. Paul.

R. K. Stockwell, Assoc. M. Am. Soc. C. E., recently Chief Engineer and Superintendent of Construction of the Braden Copper Co., at Rancagua, Chile, will soon open offices in Salt Lake City, Utah, as the engineering and sales representative of the Robins Conveying Belt Co., of New York.

F. W. Claflin, Assoc. M. Am. Soc. C. E., Assistant Engineer of Grade Crossing Elimination, New York, Chicago & St. Louis R.R., Cleveland, Ohio, has resigned to accept the position of Superintendent of Construction for S. M. Marshall, Consulting Engineer, New York City, on work in Toronto, Ont.

W. H. Kutz has been appointed City Engineer of Parsons, Kan. He was graduated from Kansas University in 1904 and has been with the engineering departments of the Missouri, Kansas & Texas Ry., the Atchison, Topeka & Santa Fe Ry., the United States Land Office and the Denver Union Water Co.

G. W. Ellis, Assoc. M. Am. Soc. C. E., has been appointed City Engineer of Pratt, Kan. He is a graduate of Kansas University, class of 1908, and was for six years employed by Burns & McDonnell, Consulting Engineers, Kansas City, Mo Later he was City Engineer and Superintendent of Water-Works at Osage City, Kan.

James W. Long will terminate his services as Bacteriologist of the Trenton, N. J., water-purification plant Feb. 28, the office having been abolished. The reason given in the published report of the city commission is that of economy, the work in the future will be done by the superintendent of the plant with a laboratory assistant, under the supervision of the City Chemist.

L. K. Rourke, M. Am. Soc. C. E., former Commissioner of Public Works, Boston, Mass., has accepted a position in an advisory capacity with the Chile Exploration Co. and the Braden Copper Co., of New York City. He has recently returned from a trip to Chile and will leave again for that country within a month. He states that mining industries are active and that many public-works improvements are contemplated in Chile, but that the latter are, and probably will be, handled chiefly by Chilean engineers.

E. B. Merriam, for several years Assistant Engineer of the Switchboard Department of the General Electric Co., has resigned his position to assume much more important duties. He now heads the Industrial Service Department recently organized to supervise education, employment, and provision of opportunities for advancement of employees at the Schenectady plant of the company. He has been connected with the General Electric Co. for 16 years, starting as a student in the testing department and later doing service in commercial, manufacturing and engineering development and research departments.

S. T. Henry, Assoc. Am. Soc. C. E., has resigned as Second Vice-President of the McGraw Publishing Co., New York City, to become Vice-President of a subsidiary of the American International Corporation, which will handle the export of contractors' machinery and equipment. He is a graduate of the University of Illinois, class of 1904, and joined the editorial staff of "Engineering Record" the same year. For a time he was Western Editor at Chicago and afterward Advertising Representative. Recently he has been active in the business management of all the McGraw Publishing Co.'s technical papers.

Charles A. Norman, formerly instructor in charge of farm-structure work, Purdue University; **L. H. De Muth,** formerly manager of the Cement Stave Silo Co., Sedalia, Mo., and a graduate in agriculture of the University of Missouri; and **W. G. Kaiser,** formerly experimentalist in farm building design, Iowa State College, have recently taken positions with the Portland Cement Association at the Chicago headquarters. These men will devote their efforts to extending the activities of the Extension Division Farm Bureau of the Portland Cement Association. Mr. Kaiser will have charge of farm building design, Mr. De Muth will devote his attention to rural-contractor coöperation and general farm-promotion work, while Mr. Norman will be engaged in investigational inquiry work.

Walter Kidde, Engineer-Constructor, New York City, has incorporated his organization under the title of Walter Kidde & Co., Inc. Mr. Kidde's chief associates, who have been his partners on the "Carnegie plan," now become directors and stockholders of the new corporation, the officers of which are: Walter Kidde, President; B. G. Worth, Vice-President; I. R. Lewis, Secretary and Treasurer. These are all members of the Board of Directors, which also includes Henry Lang, who is Vice-President of the Ingersoll-Rand Co., and E. S. Boyer, who is associated with the American Hard Rubber Co. The other principal associates, who comprise the "engineering board" of the corporation, are: A. B. Miller, Walter S. Wainright, M. I. Buttfield, and E. Schwarz. The chief draftsman is Thorlief Fliflet.

OBITUARY

Oliver Howell Crittenden, Chief Engineer of the International & Great Northern Ry., died Jan. 27 at his home in Houston, Tex.

James K. Lake, a retired engineer and contractor of Chicago, Ill., died Jan. 23 at his home in Council Grove, Kan. He was born in Connecticut and went to Chicago in 1858.

Charles J. Moore, a prominent mining engineer of Denver, Colo., died at his residence in that city on Jan. 28, after a month's illness. Mr. Moore was born in England, but had resided in the United States during nearly all his active business life. In the early '70's, Mr. Moore made the acquaintance of George H. Frost, the founder of "Engineering News."

When Mr. Frost began the publication of this journal at Chicago in April, 1874, Mr. Moore assisted him in editing it until the close of the year, when he returned to New York City. Mr. Frost's original idea in founding the journal was to publish a paper exclusively for land surveyors. It was through Mr. Moore's influence that he chose a wider field and adopted as the title for the journal, when first issued, "The Engineer, Architect and Surveyor." During his residence of over 40 years in Colorado, Mr. Moore was connected with some of the principal mining developments in that state at Leadville and Cripple Creek, and later at Goldfield, Nev. He was connected with the Portland mine at Cripple Creek for a number of years and located and developed some of the best mines in Goldfield. Mr. Moore is survived by his widow and one son.

Lyman E. Cooley, Consulting Engineer, of Chicago, died on Feb. 3 after a brief illness. He addressed a meeting of the Western Society of Engineers on Jan. 31. Mr. Cooley was born at Canandaigua, N. Y., Dec. 5, 1850, and graduated at Rensselaer Polytechnic Institute in the class of 1874. He was for three years a teacher in Northwestern University and for six years, from 1878 to 1884, was in the United States Engineer Service, engaged in the improvement of the Mississippi and Missouri Rivers. He first became prominent for his energy in promoting the undertaking of the Chicago Drainage Canal. He served as its Chief Engineer for some time, and when through some political combinations he was displaced, he was elected one of the Trustees of the district. In 1895 he was appointed by President Cleveland a member of the Commission to make investigations for a ship canal between the Great Lakes and the Atlantic; and he was prominent in connection with all the later plans for deep-water navigation to the Lakes. He was Consulting Engineer of the Lakes-to-the-Gulf Deep Waterway Association for several years. Besides his work in connection with waterway development, he did notable work in connection with water-power enterprises and water storage at Keokuk, Iowa, and at Denver. Mr. Cooley was a prolific writer on the engineering subjects in which he was interested. He was Editor-in-Chief of "Engineering News" for a year, in 1876-77, and was for many years afterward a frequent contributor to its columns. In 1884 he with some associates founded "The American Engineer" in Chicago, but his connection with it was brief. He delivered lectures on waterway topics at Illinois, Michigan and Wisconsin universities and was given the degree of Doctor of Engineering by Michigan University, in 1915. He became a member of the American Society of Civil Engineers in 1898, and was President of the Western Society of Engineers in 1890-91. He leaves a son, a daughter and seven brothers, one of whom, Dr. M. E. Cooley, is Dean of the Engineering College of Michigan University.

ENGINEERING SOCIETIES

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

AMERICAN ASSOCIATION OF ENGINEERS.
Feb. 8-10. In Chicago at the Hotel La Salle.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

ARKANSAS ENGINEERING SOCIETY.
Feb. 13-14. Annual meeting in Little Rock. Secy., Wm. J. Parkes, Pine Bluff, Ark.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 14-15. Annual meeting in Indianapolis. Secy., W. F. King, Indianapolis, Ind.

WISCONSIN ENGINEERING SOCIETY.
Feb. 15-16. At Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 19-22. Meeting in New York City. Secy., Bradley, Stoughton, 29 W. 39th St., New York City.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb 20-21. Annual meeting in New Haven in Mason Laboratory. Secy., J. F. Jackson, New Haven.

IOWA STATE DRAINAGE ASSOCIATION.
Feb. 20-21. Meeting in Fort Dodge. Secy. M. F. P. Costelloe, Ames.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting in Ames. Secy., J. H. Dunlap. Iowa City.

The Idaho Society of Engineers at its recent convention elected the following officers: President, Will H. Gibson; vice-presidents, W. O. Cotton and G. C. Scharf; secretary, Ira F. Shaffner, of Boise, Idaho.

The Engineers' and Architects' Association of Southern California elected on Jan. 27 the following officers for 1917: President, A. H. Koebig; vice-presidents, A. S. Bent and I. J. Francis; secretary, H. Z. Osborne, Jr., City Engineer of Los Angeles.

The Engineers' Club of Minneapolis has elected the following officers for 1917: President, E. H. Scoffield; vice-president, Walter F. Milnor; treasurer, P. R. Thompson; secretary, E. W. Ashenden.

The Engineering Society of York, Penn., at the recent annual meeting elected the following officers: President, George A. Jessop; vice-president, Chauncey D. Bond; treasurer, Harold A. Russel; secretary, M. H. Frey, Polack Building, York, Penn.

The American Institute of Mining Engineers convenes in New York City on Feb. 19 for the annual meeting. In addition to the regular business and the presentation of technical papers there will be an all-day excursion by special train to West Point.

The Indiana Sanitary and Water-Supply Association holds its tenth annual meeting Feb. 14 and 15 at Indianapolis at the Claypool Hotel. In addition to the various papers and committee reports, there will be four roundtable discussions on the following subjects: "Surreptitious Use of Water," "Meter Department Operation," "Water-Works Accounting," and "Extension of Distribution System." A leaflet has been distributed containing questions intended to serve as a guide in the discussions.

The Building Officials' Conference will be held in Washington, D. C., May 10 and 11, which time will coincide with that of the annual meeting of the National Fire Protection Association. A joint meeting of the two societies will be held on May 10. There will be an address on safe and unsafe scaffolds and the prevention of accidents to building workmen, and a paper describing the organization and purpose of building departments throughout the country. The secretary is Sydney J. Williams, Madison, Wis.

The Connecticut Society of Civil Engineers holds its thirty-third annual meeting in New Haven Feb. 20 and 21. Among the papers to be presented are "Deep Foundations," by James W. Rollins, of Holbrook, Cabot & Rollins Corporation; "The Development of Car-Float Transfer Bridges in New York Harbor," by J. B. French, and "Notes on Construction and Maintenance of Electric-Railway Track," by P. N Wilson. The annual dinner will be held at the Hotel Taft, at 6:45 on the first day. The secretary is J. Frederick Jackson, New Haven, Conn.

The Ohio Engineering Society held its annual meeting in Columbus, Jan. 29 to Feb. 2, electing the following officers: President, A. R. Taylor; vice-president, T. J. Smull; secretary, John Laylin, Norwalk. The principal subject under discussion was a proposed Columbus Engineering Society. About fifty of the members present indicated a willingness to join such an organization, and a motion was passed unanimously providing for a committee to be appointed by the president, which would meet with a like committee of the Ohio Society of Mechanical, Electrical and Steam Engineers, looking to a consolidation of the two. The next annual meeting of the Ohio Engineering Society will be held at Columbus, and at that time it is likely that there will be a general convocation of Ohio engineers.

The Society of Terminal Engineers has just been chartered under the laws of New York, with headquarters in New York City. Its purposes are to promote the study of terminal engineering and of mechanical freight handling. There are members, associate members and juniors. The members' grade is open to engineers specializing in terminal work and to professors of civil and mechanical engineering. Associate membership applies to officers and others connected with concerns manufacturing freight-handling appliances and terminal equipment. Junior members comprise recent technical graduates. The dues are $6 a year, without initiation fee for the first year. It is expected that monthly meetings will be held. The officers are: President, H. McL. Harding; vice-presidents, Gen. W. H. Bixby and John Meigs; treasurer, W. J. Barney; secretary, J. Leonard, 1133 Broadway, New York City.

The Engineers Club of New York City, although a purely social organization and not a technical society, is of especial interest to engineers because its membership is made up very largely of prominent members of the principal national engineering societies. The club's house in New York City is located in 40th St., closely adjacent to the Engineering Societies' Building on 39th St. The money to erect the club build-

ing was given by Andrew Carnegie at the same time that he made his great gift for the building of the national engineering societies. The annual report of the Board of Managers of the club, just issued, shows a total membership of 2146, of whom 1200 reside in or near New York City. The distribution of members in the profession is indicated broadly by the list of 94 members elected during 1916. Of these, 39 were mechanical engineers, 20 electrical engineers, 10 civil eng'neers, 7 mining engineers, 7 marine engineers, and the remaining 11 were manufacturers, contractors, efficiency engineers, etc. The club had a gross income last year of about $485,000, and its expenses were about equal in amount. The total assets are about $1,150,000, and practically its only liabilities are a mortgage for $300,000 on its real estate. E. G. Spilsbury is the President of the club for 1917, and Joseph Struthers is Secretary.

Appliances and Materials

A Suit Life Preserver

A buoyant suit designed primarily for use as a life preserver is announced by the National Life Preserver Co., 11 Broadway, New York City. The suit, known as the "Ever-Warm," was invented by O. A Youngren and is made in "union" style—in one piece with shoes and mittens—completely inclosing the body, with the exception of the head, which is protected by a waterproof cap. Lead soles keep the wearer right side up. The suit is of waterproof material and does not depend for buoyancy upon air that may be confined within it. The upper portion is lined with "Ilanasilk," a waterproof material claimed to be five times as light as cork. The suit is not easily punctured, but it may be filled with water without diminishing its buoyancy. Across the upper front, between the shoulders, is a wide opening; this is closed, after putting the suit on by hinged half-hoops snapped together. The head comes through a hole in the flap top.

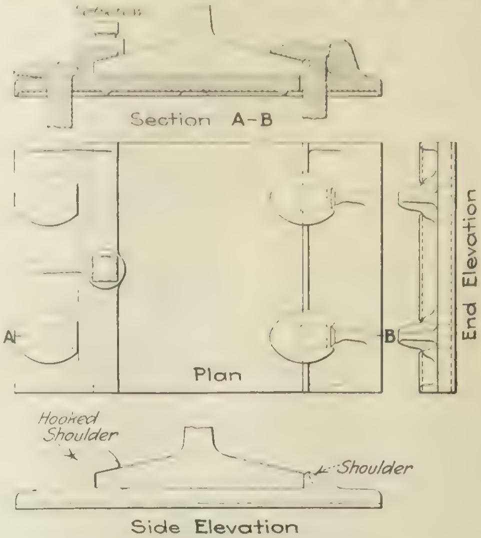
* * *

Rail-Anchor Tie-Plate

The Thomas rail-anchor tie-plate, shown herewith, combines the functions of a tie-plate and an anticreeping device. It has been applied with success, not only on the open track, but at points on terminal lines where conditions of track crossings, sharp curves and heavy traffic unite to make it difficult to hold track in line and gage. It is manufactured by the Chicago Malleable Castings Co., of Chicago, Ill

The device is a malleable-iron tie-plate with a hooked shoulder to grip one side of the rail base, and a plain shoulder to fit against the other side. The width between shoulders is made an exact fit for the rail base. On the side of the hooked lug, the plate is secured by one or two spikes that do not engage the rail. On the other side are similar spikes that hold both the rail and the plate. A special feature is a lug or shoulder at the back of each of these latter spike holes, so shaped as to hold the spike tightly against the rail and to prevent the spike from being driven in an inclined position. In this way the rail is held firmly between the spikes and the shoulder.

To prevent any longitudinal motion or creeping, a setscrew in the hooked lug is screwed down so as to bite into the rail base. No great force is required for this; and where the device has been in use for a considerable time, it has been found that the setscrew neither rusts tight nor works loose. The bottom of the plate has shallow ribs, as shown. The device may be used on all or a portion of the ties, according to the extent of the trouble with creeping. Some roads prefer it on all ties, even where this trouble is less serious, rather



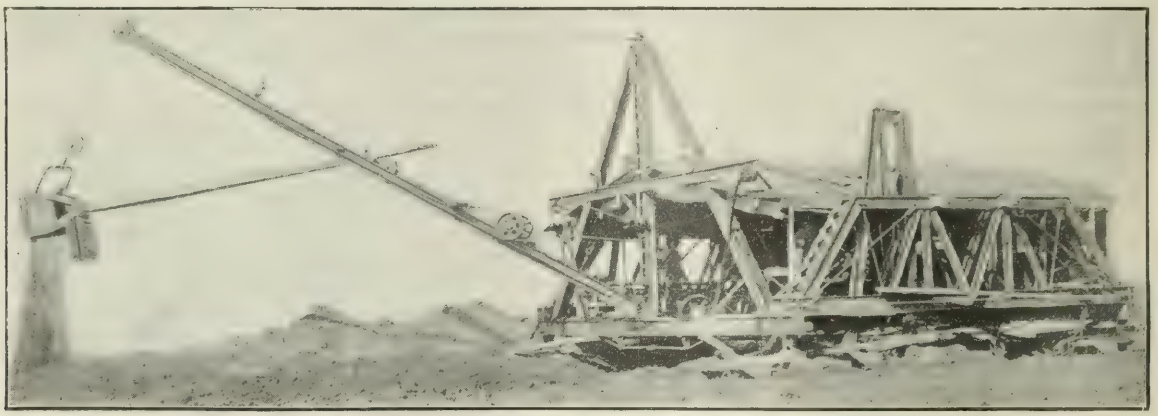
COMBINED TIE-PLATE AND RAIL ANCHOR

than have two different kinds of tie-plate in use in the same stretch of track.

* * *

New Walking Land Dredge

A new kind of walking land dipper dredge using a series of feet in place of steel trucks and sectional track is announced by the Bay City Dredge Works, Bay City, Mich. Four corner feet are attached permanently to the four corners of the dredge, and two large movable feet are located in the center, one on each side. The dredge body, together with the corner feet, is lifted and pulled forward by winding up a move-up cable on a hoist drum. Then the center foot-frames are pulled forward and another cycle repeated. From 5 to 10 ft. is covered per shift and two steps can be made per minute. The dredge can move across open country at the rate of 1 to 2 mi. in 10 hr. Ground that is rough, marshy, soft or slippery does not impede the walking dredge, and no track, skids or extra planking is required. The manufacturer has had one of these dredges in service during the digging season of 1916 in northwestern Minnesota.



WALKING DREDGE WITH TWO MOVABLE AND FOUR STATIONARY FEET

* * *

Another Thin-Plate Air Valve

The Mesta Machine Co., of Pittsburgh, is now using on its blowing engines and compressors a thin-plate valve made under the Iverson patents. It was intended to be adopted only for new equipment, but it was found possible to install it easily and cheaply on old machines. The valve consists of a light, thin, annular steel plate carried and guided by a flat volute spring. The valve plate is not deformed in operation, but keeps parallel to the seat. In common with most modern plate valves, the valve movement is small, full opening is quickly secured, very little back pressure is caused, and there is no appreciable wear. Increases are reported of from 10 to 35% in air delivery without increased piston speed. An increase in efficiency of 1 to 5% is also claimed.

Engineering News

VOLUME 77 FEBRUARY 15, 1917 NUMBER 7

Southern Power Company Adds 40,000-Hp. Capacity to Its System

By starting up the 40,000-hp. Fishing Creek station of the Wateree Power Co., at the close of 1916, the Southern Power Co. placed in service the largest of its seven hydraulic stations and completed the 100,000-hp. development of the Great Falls district of the Catawba River near Charlotte, N. C. The site of the new station is just above the entrance of Fishing Creek into the Catawba, and at the head of the rapids locally known as the Great Falls. Below the new station are the Great Falls and Rocky Creek stations of the company, each of 32,000-hp. capacity.

FIG. 1. FISHING CREEK DAM AND STATION DURING CONSTRUCTION

View from downstream on June 1, 1916, showing the use of material tracks and tall steel derricks by the contractor, the Hardaway Contracting Co., of Columbus, Ga.

The accompanying map (Fig. 2) shows the great development of the Southern Power Co. system of transmission lines as it exists today. There are, in round numbers, 470 mi. of 100,000-volt power lines, 20 mi. of 100,000-volt pole lines, 140 mi. of 44,000-volt power lines, 370 mi. of 44,000-volt pole lines and 30 mi. of 11,000-volt pole lines. These lines are exclusive, of course, of the numerous distributing lines of the associated Southern Public Utilities Co., which is the concern retailing energy in the various communities.

Figs. 1 and 3 show the Fishing Creek development from upstream and downstream. The dam and station extend across the river in a straight line, about 1850 ft long. The dam itself is of 50-ft. maximum height and is of gravity overfall section for the entire length, except where consolidated with the power-house foundation. There is a free spillway of about 1100 ft. and between this and the station is a section with 12 hinged floodgates, between piers, lowering into recesses in the

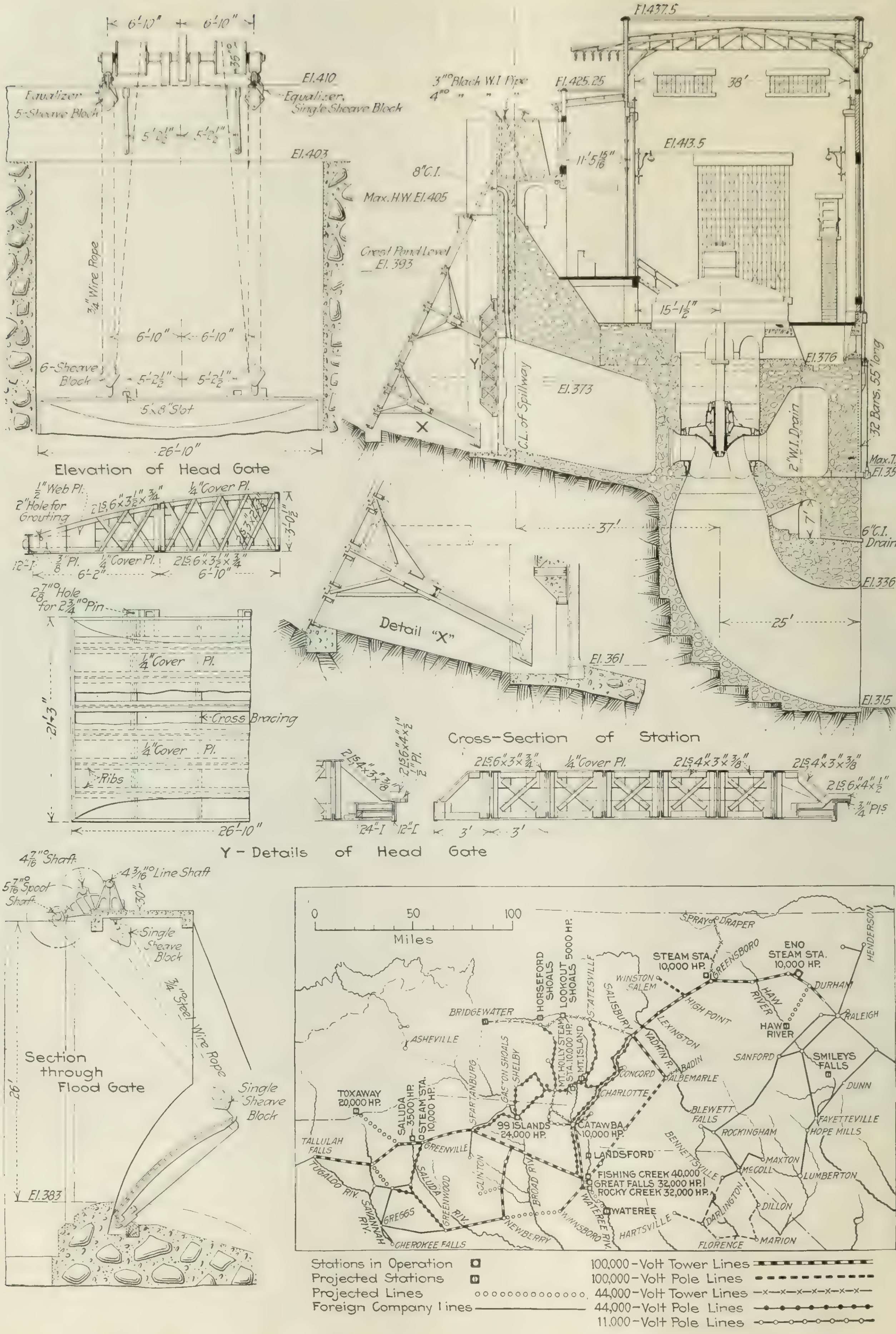


FIG. 2. MAP OF SOUTHERN POWER CO. SYSTEM AND DETAILS OF FISHING CREEK DEVELOPMENT

top of the dam and operated by cables and motor-driven winches (see Figs. 2 and 3). The overall length of the gated spillway is about 192 ft., and the length of free waterway aggregates 120 ft. The dam contains 110,000 cu.yd. of cyclopean concrete.

The power house is 250x40 ft. in plan. The building substructure, draft tubes and turbine scroll cases are combined with the dam at this point. The draft tubes increase from 12-ft. 9-in. circles to 19x37-ft. ellipses. The intakes are 20x26 ft. in section at the headgates. The foundations contain about 40,000 cu.yd. of masonry. The superstructure is a steel frame with brick walls, and the roof is a tar and gravel composition (Barrett specification).

The headgate construction is unusual, as may be seen from Fig. 2. The gate itself is a simple concrete-filled steel frame, weighing complete 216,000 lb. in air and 156,000 lb. submerged. There are no thrust rollers, etc. The gate is lifted by a motor-driven winch with two drums. The weight of the headgates is designed to close them under full operating head. To facilitate raising, a 2-ft. bypass is provided to fill the intake and scroll case, the turbine wickets being built to close tight and allow but slight leakage.

The design of the racks is unusual, as will be seen from Fig. 2. Each rack frame is braced to a pair of inclined steel arches, set with their haunches in niches in the piers separating the intakes. This design is intended to carry full hydrostatic pressure—as when the racks are stopped with driftwood. Also, the racks are intended to be used as stop-log frames, should it ever be necessary to work in the intake or scroll case with the headgate up.

In the power station are five turbines, each built to develop 10,800 hp. at 97.3 r.p.m., under 57-ft. head. The runners are of cast iron in a single piece, 8 ft. high overall and 12 ft. 9 in. in diameter at the band. The rated diameter (midway between hub and band) is 105 in. The runner weighs 58,000 lb. The speed rings are 17 ft. in diameter and 9 ft. high. The wicket gates are of cast steel, are hollow and have a hollow gate spindle. Through the latter, oil is delivered to a bronze bearing in the bottom plate. The guide vanes of the speed ring, outside the wickets, have cored openings through which any water that leaks above the runner and top plate and along the gate stems may pass off into the draft tube. In this way pressure that ordinarily piles up on top of the runner is relieved.

Each wheel carries a 74-pole 7500-kv.-a. 6600-volt generator, with a 95-kw. 250-volt shunt-wound exciter on top. The total load of the revolving part, including water thrust, is 275,000 lb., and it is carried on a spring thrust bearing mounted on a heavy deck above the generator frame. The outside diameter of the stator is 44 ft. 2 in., and this part weighs 77,500 lb. The rotor is 20 ft. in diameter and weighs, with its shaft, 118,000 lb.; its WR^2 is 7,000,000.

Stepping up the voltage from 6600 to 101,200 volts is done outside the power house in an outdoor-type of substation. Transformers and high-tension oil circuit-breakers and disconnecting switches are all of the outdoor type. All the main switches are of remote-control design, operated from a central bench board. There are seven single-phase water-cooled 60-cycle 5500-kv.-a. transformers, in two banks with one spare unit. These are on trucks to facilitate handling and are fitted with the latest equipment in the way of thermometer alarms, breathers, etc.

This development was carried out by the Wateree Power Co., a subsidiary of the Southern Power Co., under W. S. Lee, Vice-President and Chief Engineer, and A. C. Lee, Assistant Chief Engineer. The contractor was the Hardaway Contracting Co., of Columbus, Ga. The turbines and governors were built by S. Morgan Smith Co., of York, Pa.; the generators, exciters, substation equipment and other important pieces of electrical apparatus were made by the General Electric Co., of Schenectady, N. Y.

Statistics of Railway Grade Crossings in the United States are presented in the annual publication of the Bureau of Railway Economics of Washington, D. C., just issued. There are 255,606 grade crossings in the United States, of which only 31,602 are protected by gates, flagmen, or other apparatus. Of the class of grade crossings where one steam railway crosses another, 5903 are protected and 4164 are unprotected. Of grade crossings of steam and electric railways, 2491 are protected and 2215 are unprotected. Of highway grade crossings, 16,000 are protected by gates and flagmen, and 7000 by crossing alarms, and 217,000 have no protection. The elimination of grade crossings makes very slow progress. During 1915 there were eliminated 44 steam railway grade crossings; 17 grade crossings of steam and electric railways, and 466 grade crossings of railways and highways. It should be noted that these statistics cover only railways having annual earnings above $100,000. A great number of grade crossings on short railways of light traffic are therefore not included.

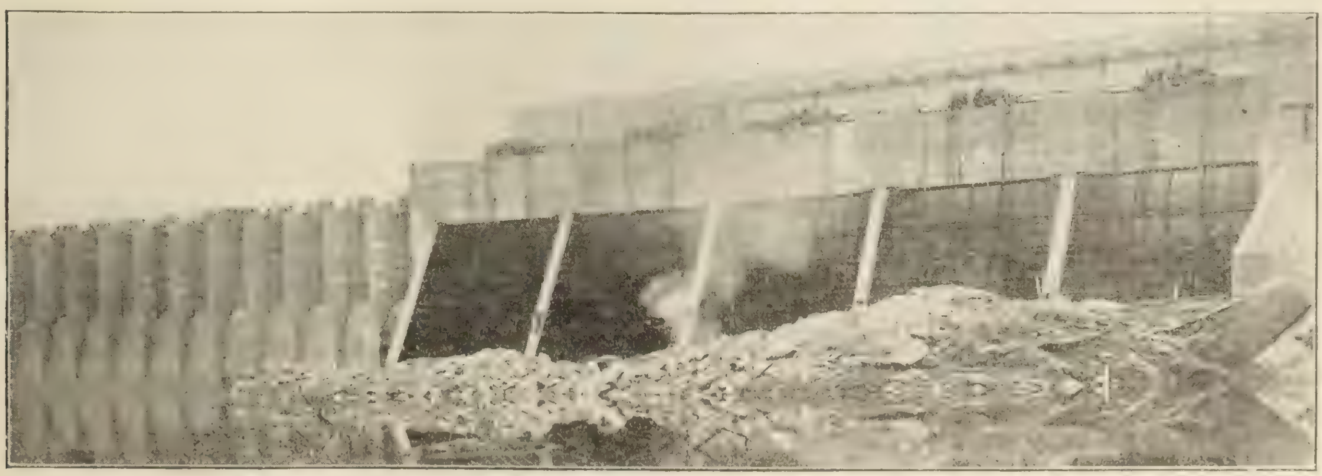


FIG. 3. FISHING CREEK DAM AND STATION DURING CONSTRUCTION
View from upstream on Nov. 12, 1916, showing racks, headgate hoists, floodgate piers and hoists, etc.

The Miami Valley Flood-Protection Work

V—New Features in the Specifications

Specifications for Contract Work Which Have Been Especially Drawn To Secure Good Contractors and Low Cost; Extensive Departure from Precedent; Clearness and Equity; Engineer's Authority Limited

The contract specifications for the $20,000,000 Miami flood protection are as strikingly new and individual as the plans for the work. The specifications have been designed, not compiled. They are an instrument devised to handle the varied work of the huge enterprise effectively, to secure the best contractors, to get lowest contract prices and to produce good work without delays or contention.

The preliminary engineering of the Miami Conservancy District had been so directed as to secure a mass of data on rock, soils, water and other conditions. By means of this survey, many questions had been determined in advance that ordinarily must remain unsettled until long after the contractor begins work. This fact, coupled with the desire to make all the advance information available to bidders, exerted a profound influence on the shaping of the specifications.

The engineers have tried to make the specifications clear, thorough, fair and businesslike, and they seem to have succeeded to a remarkable degree. If in the actual administration these specifications bear out their present promise of efficiency, they will have blazed a new trail through the tangle of contract difficulties.

To indicate a few of the prominent features of these specifications: They give a large amount of advance information, tending to reduce the bidder's uncertainties and risks. They make provision for many of the contractor's requirements, such as camp sites, borrow pits and dumps, thereby eliminating further elements of costly uncertainty. They define the contractor's obligations so comprehensively and precisely that at no time is there room for doubt as to what he must do and what he need not do. They set forth the business relations and procedure in definite and satisfactory manner. They bind the owner to as careful observance of terms as they do the contractor. They provide numerous safeguards for the contractor's interests, limiting the arbitrary power of the engineer; but they arm the engineer with great power of decision and compulsion in those matters where the success of the work, or the welfare of the public, may require that he be free to direct, and to enforce his demands. They call for normal quality of work except where specially high quality is needed, but in these latter instances they set forth the required quality in such plain terms as to insure its being obtained.

Points of interest, though they may be secondary, reside also in the simplicity of the language—that is, the elimination of much complex legal phraseology and other heritages of tradition—and in the great reduction of clauses specifying "the engineer's satisfaction." With respect to the latter, a special campaign was made to eliminate the phrases "approved," "satisfactory," "as directed," "to the engineer's satisfaction," etc. One of the final drafts of the specifications was gone over in detail by two members of the engineering organization who are experienced in heavy construction work, and every instance of these terms was studied to find out whether definite description of a desired result could be substituted. This laborious revision is the more worthy of notice here because its results are likely to be overlooked, since they show only in a negative way.

The specifications are unusually businesslike. In stating time and terms of payment, in specifying results and methods in a measurable way, in providing for successive partial release of surety, in facilitating the adjustment of the final estimate, and in many other ways, their tendency is to establish systematic business relations, largely freed of the personal factor.

A valuable feature is the quick-reference arrangement of the document. It is essentially a self-indexing system, tied and referenced to the unit-price items of the bid.

The Mechanical Arrangement; A Self-Indexing System

The specifications have three divisions: General Conditions, General Specifications and Detail Specifications. The latter division, intended as the primary reference portion, is divided into numbered sections, or "items," 1 to 90, which deal with the separate classes of work included in the contract. Each item corresponds to the bid item bearing the same number, as Item 1, Stream Control at Dams; Item 56, Laying Vitrified Round or Channel Pipe; etc.

Whatever part of the work the contractor may be engaged in, knowing the numbered item of the bid schedule under which he is working he has only to look up the detail-specification item bearing the same number. This gives him at once all the necessary engineering and accounting information, a statement of the kind of work covered by the item, directions for doing the work and the conditions of measurement and payment, or a reference to appropriate paragraph numbers of the General Specifications.

As may be understood herefrom, clauses of general applicability to methods are grouped separately to form the division General Specifications. Sections here included are such as Assistance in Making Tests, Protection of Existing Structures, Embankment (six methods of embankment construction are described and specified in minute detail), Concrete (fine aggregate, coarse aggregate, water, forms, mixing, placing, etc.). Similarly, the relations between the two parties and all matters auxiliary to construction, as Camps, Medical Supervision, Extra Work, Hindrances and Delays, Payments, etc., are covered in the division General Conditions. The clauses of the General Conditions are numbered 0.1 to 0.57, and those of the General Specifications 0.57 to 0.105, which successfully avoids all confusion with the item numbers of the Detail Specifications.

Individual specifications for each of the separate contracts in the enterprise are prepared from the main or consolidated specifications by simply omitting item para-

graphs for work not included in the particular contract. The numbering is retained unchanged, so that, whatever the contract may be, Item 5 is "Excavation, Soil Stripping," and Item 37 is "Backfilling." This expedient is an important safeguard against mistake, in dealing with a large number of contracts.

With regard to the element of fairness, it is pertinent to state that this was considered vital. Many clauses virtually specify the engineer's fairness. Thus, in the clause empowering the engineer to direct the manner of conducting the work, an added phrase, "in so far as may be necessary to secure the safe and proper progress and quality of the work," was introduced for the purpose of putting the burden of proof on the engineer and limiting his right to dictate. And under the same head the responsibility for preventing interferences between different contractors is placed on the engineer in express terms. Where inspection of work involves damage to such work, the contractor is to be compensated for this damage unless the inspection reveals bad work.

That a great deal of arbitrary power is yet left to the engineer, notwithstanding this desire to be wholly equitable, is to be explained by the possibility that contracts may have to be let to the lowest bidder, according to the underlying law, unless the Conservancy Court sanctions another award.

The district undertakes to furnish the contractor all right-of-way, all camp sites at dams, and ground for borrow and dumping. In consequence it has been possible to state many requirements more specifically than is usual in contracts, and on the other hand certain provisos had to be made for failure of the district to furnish these facilities promptly.

Definitely Limited Authorization for Extra Work

Carefully drawn safeguards surround the subject of extra work. These act as a check against a contractor's possible inclination to regard every instruction given him as cause for a bill for extras. On the other hand, equal care has been taken to point out specifically those cases where a claim of compensation for extra work is admissible. Thus, failure to furnish right-of-way calls for compensation:

> In case of serious delay and loss to the contractor because of failure of the district to furnish right-of-way which in the opinion of the engineer is necessary to the work, the contractor shall be compensated for such loss.

Similarly, when work is stopped by the engineer's direction for any cause other than is specifically authorized in the contract, compensation for extra expense is to be paid.

In general it is provided that extra work (to be ordered in writing by the engineer) shall be paid at actual cost plus 15%, the cost being without overhead. However, if the engineer orders change or increase of plant to promote progress, it is to be considered as regular work done under the contract. Similarly, specific exception is made of night work. Provision is made for claims for damage caused by acts or omissions of the engineer.

In contrast with the individuality of the extra-work clause is the way in which the related matter of changes in plan is disposed of. The right is reserved to the Board of Directors to make such changes as it may elect "in the line, grade, form, location, dimensions, plan or material" of any part. The contractor has no claim (beyond payment at the bid unit prices) except for work done or material furnished that is rendered useless by the change. There is no clause in this section limiting the amount of reduction without compensation for profits, but in this connection the form of bond provides that no alteration shall be made, without the consent of the surety, which will "alter the general character of the work as a whole, or . . . increase the total amount to be paid to the contractor by more than 25%."

How the Time Question Is Handled

The contract lays special stress on time of completion. It segregates from the contract time an initial period agreed upon as the "period of preparation," during which the plant is to be assembled and working forces are to be organized. In computing rate of progress, seasonal weather conditions are taken into account by rating as two working months the winter period from Dec. 1 to Mar. 31, while the remaining calendar months are rated as equivalent to ten working months. The expected winter rate is therefore only two-fifths of the expected summer rate, as measured in ordinary working days.

The contract fixes as liquidated damages for noncompletion at the specified time (or as it may be altered by extensions) a sum made up of two parts, one sufficient to compensate for the expense of employing engineers and inspectors, etc., and the other representing for each month ½% on all money paid to the contractor. These provisions, which put the matter of damages on a mathematical, wholly defensible basis, are considered so fundamentally important that they are embodied in the "agreement," while the further clauses bearing on time are in the specifications.

The contractor must take note of all data and information collected by the engineer and on file for his inspection, and of all adverse conditions; but there is the following important limitation of his responsibility with regard to time:

> It is understood, however, that as to river and weather conditions the contractor shall provide against the most adverse conditions and circumstances which reasonably are to be expected to occur on the average within a 15-year period as shown by past records.

The extensive rainfall and flood researches of the district (see *Engineering News*, Jan. 4, 1917) afford specific information on the magnitude of the average 15-year flood and rainfall.

Extensions of time are specifically declared to be possible, in several different clauses, for delay by legal injunctions (if this unavoidably delays the entire contract and not merely parts thereof), for failure of the district to furnish right-of-way and for other similar reasons.

Measurement and Payment Defined in Precise and Equitable Manner

A novel stipulation applies generally to all measurement:

> Unless specifically so stated in detail in the contract or specifications, no extra measurements, or measurements according to local custom of any kind, shall be allowed in measuring the work under this contract; but only the length, area, solid contents, number, weight or time in standard units, as the case may be, shall be considered.
>
> It is stipulated and agreed that the planimeter shall be considered an instrument of precision adapted to the measurement of areas.

Two interesting pieces of extra allowance of earthwork are in the cutoff trenches and in road construction:

> 6.2 Maintenance During Construction—Should material
> 7.2 wash into a cutoff trench before the placing of em-

8.2 bankment, or stony gullies due to wash be formed.
6.2 such material and stones shall be carefully removed,
7.2 if directed, and the contractor shall be paid the contract
8.2 price per cubic yard for material so removed.
19.5 Maintenance During Construction—The contractor
20.5 shall keep the surface of the roads constructed under
21.5 this contract in good condition, during the life of the contract. When so ordered, he shall fill any depressions caused by settlement or by wear and tear due to use, and he shall be paid therefor at the unit price stipulated for the respective items entering into such repairs.

A still more important provision along the same line is introduced in connection with river excavation for channel improvement:

9.2 Payment—Payment for these items will be made in
10.2 accordance with Section 0.71 of the specifications,
11.2 entitled "Excavation Payment," with the following exceptions:

Any material that washes into the cut through no fault of the contractor shall be removed by him at the unit price per yard stipulated for these items.

Some individual points of care to avoid trouble attract notice. Under Borrow Pits, warning is given that borrow will not be estimated as excavation (except in specific cases separately provided for); that pits when abandoned (and there is a similar clause for spoil banks) must be shaped and graded, and, if ordered, topsoiled and grassed; that the shaping is included in the item price, but topsoiling and grassing is paid for as a separate item. Excavation of test pits will be credited as extra work. Controlling any springs on the site of an embankment will be paid for, as regards material used, and excavation.

Doubt as to what is included in a given payment item is dispelled by such clauses as the following for concrete:

0.104 Concrete, Prices To Include—Except for cement, reinforcing steel and other metalwork, as provided elsewhere, the unit prices for the different items of concrete shall cover the entire cost of construction thereof, which shall include the cost of materials for fine and coarse aggregates, and of large stones; the cost of all mixing, conveying, placing of concrete and large stones; the cost of damming, bulkheading, pumping, bailing; the cost of preparing foundations, piping or otherwise caring for water, and removing laitance; the cost of grout wash or mortar beds used in building upon old work or on rock, and of coatings for contraction joints; the cost of protecting concrete against frost, floods and injury from other sources; the cost of erecting and removing forms, centers, molds, bracing, landing platforms and scaffolds, and of the lumber, steel, nails, wire and other material used therein; the cost of finishing, patching and wetting; the cost of removing and replacing defective work; and any other work and materials necessary to complete the concrete construction as required by this contract.

But such unit prices shall not include the cost of furnishing cement, the cost of furnishing and placing reinforcing steel, piping, conduits, structural steel, castings and other metal work, which shall be paid for under the items provided therefor.

Even more instructive is the manner in which payment for steel reinforcement is handled:

51.3 Payment—The quantity of reinforcing steel to be paid for shall be the number of pounds placed in accordance with the drawings or orders. The unit price stipulated for this item shall include the cost of metal, the royalty, if any, the cost of transporting, cutting, bending, placing, fastening in position, cleaning, protecting and all other labor and materials connected therewith. Waste material, due to the fact that the lengths furnished are longer than necessary, and wires, clips or other devices used for securing the metal shall not be included for payment. The quantity paid for shall include, however, extra metal in authorized laps wherever the lengths required would be unreasonably long for single bars. In determining quantities, except as the engineer may require test weighing on scales, commercial unit weights shall be used.

As already indicated, the contractor must take all risks, including the hazard of weather and flood:

The risks and uncertainties in connection with the work are assumed by the contractor as a part of this contract, and are compensated for in the contract price for the work. The contractor, except as otherwise definitely specified in this contract, shall bear all loss . . . from the action of the elements . . . or from any unexpected conditions.

Damage such as flooding of lands above the permanent dams, however, does not fall on him.

Providing for Hazards and Contingencies

With respect to the riskiest item of weather hazard—namely, that involved in stream control during construction of the dams—the above general clause is reinforced by an unusually specific statement. Payment for stream control is a lump-sum item, plus payment for certain materials by measurement (excavation, embankment, riprap). What this payment covers is set forth very broadly in Section 1.3:

The lump sum . . . shall be considered full compensation for all services, labor, material and equipment and for all the resources of the contractor used for or incidental to the operations under this item and for all risks and damages connected therewith.

Hazards that threaten not the contractor but private parties, are dealt with in a separate clause, relating to emergency work, whose opening paragraph reads:

It is understood by all parties to this contract that unusual conditions may arise on the work which will require that immediate and unusual provisions be made to protect the public from danger of loss or damage due directly or indirectly to the prosecution of the work, and that it is part of the service required of the contractor to make such provisions. The contractor shall use such foresight and shall take such steps and precautions as may be necessary to protect the public from danger of damage or loss of life or property which would result from the interruption of public water-supply or other public service or from the failure of partly completed work.

However, if the engineer finds that sufficient precautions have not been taken, he may direct the work done or have it undertaken by others at the contractor's cost. To protect the contractor against undue charges under this clause, it is provided that the Board of Directors may, for cause, allow him fair compensation.

New Classification in Excavation and Backfill

Excavation is grouped in three classes, depending on material, as has frequently been done in the past. A more precise separation is made in this instance, however, principally because of a material composed of rock interstratified with clay, which occurs in the Miami region. The three classes are defined as follows:

Class 1. Earth—Earth, as a name for excavated material, shall be used to include (except where material is classified as Class 2, Mixed Excavation) all glacial deposit, whether cemented or not, except solid boulders ½ cu.yd. or more in volume; it shall include all alluvial deposits and disintegrated material lying on top of ledge rock and all material of whatever nature not properly included under Class 2 or 3. It shall not include the Cincinnatian formation . . . earth or any material which has been classified on the drawings as Class 2, Mixed Excavation.

Class 2. Mixed Excavation—The term Mixed Excavation, as a name for excavated material, shall be used to include:

The material known geologically as the Cincinnatian formation, which lies under the glacial deposits and consists of thin, approximately horizontal layers of limestone, from a fraction of an inch to a few inches thick, alternated with and embedded in clay, and which may or may not require blasting for its removal; and

Mixtures of any or all materials which, in the opinion of the engineer, it is impracticable to classify as Class 1, Earth, or Class 3, Rock, either because of the character of the material or because of the method used in its removal.

Class 3. Rock—Rock, as a name for excavated material, shall be used to include the solid ledge-rock formation, whenever found (except when classified as Class 2, Mixed Excavation), which is pre-glacial and which can be removed properly

only by means of explosives, barring or wedging or by some other recognized method of quarrying solid rock. It shall also include existing concrete, or masonry with mortar joints, which may be removed under instructions. It shall not include thin layers of limestone embedded in clay, nor cemented gravel, nor any material classified as Class 2, Mixed Excavation.

A distinction is made in the bid schedule and in the items of the Detail Specifications between excavation below mean low water and above this elevation. Items below mean low water (when this is indicated on the plans) are distinguished from those above that level by the suffix *a;* thus, Item 13 is Earth Excavation for Outlet Work, etc., at Dams, but when this excavation is below indicated low water it comes under Item 13a.

For purposes of bidding, excavation is divided into 10 items, differing in location and purpose, which with the above classifications give ample room for varying the price according to cost.

BACKFILL DISTINGUISHED FROM REFILL—The specifications state that excavation includes making the excavation and refilling those portions that may be required. But this refers only to ordinary filling. Puddled or otherwise consolidated refill is designated as backfilling, a separate item in the bid schedule, and as described is to be done by puddling or by rolling or tamping in 6-in. layers.

EMBANKMENT MATERIALS AND METHODS

Six classes of embankment are described, covering the entire range of kind of service and method of construction. They refer respectively to the hydraulic (monitor-and-pump) method; the semihydraulic method (bringing material in by mechanical means, but sluicing it to place by hydraulic streams); the sprinkling and rolling method; and three grades of levee and road embankment. In specifying the material for the dam embankments, there are interesting points in a portion of the controlling clause:

Where Class A, Class B or Class C embankment is specified, it is the intention that the outer portion of the dam shall be composed of coarse material which shall be permanently stable under a condition of complete saturation. Any material which has a tendency to slough, slide or wash when subjected to any condition which may reasonably be expected to occur will not be acceptable. The center portion of the dam shall be composed of material containing sufficient clay or other finely divided particles to be highly impervious to water. To obtain these results the contractor shall use only carefully selected materials. Where the material from one borrow pit does not contain the requisite coarse and fine particles in the desired proportions, other sources shall be utilized; and if necessary to obtain satisfactory results, more than one class of material shall be deposited at the same time in the same or different portions of the embankment.

The preparation of rock and earth foundations for masonry structures involves a suggestion as to what tools should be used, which well indicates the expected result:

The surface shall be scrupulously freed from all dirt, gravel, scale, loose fragments or other objectionable substances. Streams of steam, air or water under sufficient pressure, and wire brushes or other effective means, shall be used to accomplish this cleaning. Steam jets or hot water shall be used to thoroughly remove snow, ice or frost, if any be found upon the foundation when it is desired to lay concrete.

WARNING AND ENCOURAGEMENT AS TO USE OF LOCAL MATERIALS

Unusual care is taken in giving the bidder and contractor advance information about the probable availability of certain materials. Thus, in a well-drawn paragraph on riprap there is contained a distinct warning against the use of most of the local stone.

58.1 Description—Riprap of required thickness and composed of tough, durable stones of the size to be prescribed shall be placed as designated in the drawings or ordered. Stones placed on or in the slopes of embankments as a result of the grading of embankment material, will not be classed as riprap. The contractor will not be required to place riprap by hand, with the exception of such handwork as is necessary to conform to the specified lines. None of the softer limestone formations found in the locality are acceptable for riprap, and only such of the harder limestone as quarry to acceptable shapes and sizes, and the large boulders, will be satisfactory.

Similar warning is contained in the specification for dry rubble paving. In the specification for concrete aggregate it is stated that, subject to test, the local gravels will be satisfactory for use as coarse aggregate if properly screened and washed, but few or none of the local ledge rocks are satisfactory.

The contractor is not only allowed, but encouraged to use in the construction all material obtained from excavation and the like. *He receives double pay* for such material, once for excavation and once for placing. Thus it will be economical for him to use material from construction rather than to borrow and waste. This clause reads, in part:

0.62 Materials Obtained from Construction—Materials from the excavations, or from clearing or stripping or other operations, which are suitable and required, shall be used in the construction, as and where directed or permitted, and shall be paid for according to the class of work in which they are used, in addition to the price paid for original removal, except in the case of embankment material for streets and highways, and of material for refilling excavations, where such refill is not designated to be paid for as backfilling.

He is also specifically given permission to enlarge excavations that do not require lining with concrete, in order to obtain material. Such material, however, is not paid for as excavation.

NOVELTIES IN THE CONCRETE SPECIFICATIONS

The engineers considered that final determination of the concrete mixtures would best be made at the time of construction, or at any rate subsequent to the drafting of the specification and receiving of bids. They therefore provided for varying the mixtures over a range generally from 1 : 2 : 4 to 1 : 3 : 6. This is made equitable by the expedient of paying for the cement as a separate item; the variation in total aggregate (sand + stone) will be immaterial as between richer and leaner mixtures.

For bidding, concrete is grouped in 11 items of different location or kind. The cement requirements are those of the specifications of the American Society for Testing Materials, published in its 1915 Year Book, with the addition, however, that 20% increase in strength must be shown from 7 to 28 days (1 : 3 briquettes) and that the tests must show reasonable uniformity of the cement. Reinforcing steel is required to be of the structural-steel grade of billet-steel reinforcement as specified by the American Society for Testing Materials, and must be "twisted or otherwise deformed." If it becomes rusty, only "loose rust scale" is required to be removed.

SAND TESTS AND CONCRETE MIXING

Sand for use in concrete must show a 28-day crushing strength at least equal to standard Ottawa sand, in 1 : 3 mortar. Limestone screenings will not be acceptable as fine aggregate. For stone, no definite tests are prescribed, but an "acceptable" mixture of sizes between ¼ in. and 2½ in. must be present. Run of crusher or run of bank shall not be used without screening. Water for concrete

must be "reasonably clean and free from oil, acid, strong alkali or vegetable matter."

A carefully worded requirement is made as to mixing:

0.93 Concrete Mixing—All operations incidental to mixing concrete shall proceed with sufficient dispatch to insure the bonding together of the successive batches as a true monolith. Concrete shall be mixed in approved mechanical batch mixers, in batches of suitable size, except that, when permitted, it may be mixed by hand in a thorough and satisfactory manner. In determining proportions of ingredients, 100 lb. of cement shall be considered 1 cu.ft. The coarse and fine aggregates shall be measured separately and uncompacted, in approved measuring boxes. Suitable means shall be provided for controlling and accurately measuring the water. The entire batch shall remain in the mixer not less than 60 sec., and longer if necessary to secure a thoroughly satisfactory mix.

After requirements for depositing, churning, spading and the usual statement of cold-weather precautions, a severe clause for protection of concrete after placing is inserted:

0.100 Concrete, Protection of—The contractor shall not permit walking or working over or upon finished surfaces of concrete until sufficiently hardened. Concrete shall be kept moist for at least four weeks or until covered with earth, and during this time shall be protected from freezing. Every precaution shall be taken to prevent concrete from drying until there is no danger of cracking or crazing due to lack of moisture. To this end concrete surfaces, unless covered with wet canvas or other equally effective material, shall be sprinkled with sufficient frequency to preclude any possibility of drying out. Alternate drying and wetting shall be particularly guarded against. Great care shall be exercised at all times to prevent injury to concrete surfaces which will be exposed in the finished work. The contractor may at any time prior to the final acceptance of the work be required to clean all exposed faces of concrete.

A very moderate demand for surface finish is put into specific terms, so that the contractor may be sure he will not be led into special expense on this account. Its essential portion calls for simply "removing in an approved manner all the rough edges and projections."

The important case of the interior of the discharge conduits is, however, covered in a very different way. Here an absolutely hard, durable, even and continuous concrete surface must be obtained in order to make sure that the high-velocity flow of water cannot do damage. For this purpose, a very rich mixture using specially graded selected aggregates and molded or finished to a true surface is called for, though the finish may be natural (from the forms):

42.1 Description—The lining of the outlet conduits, except as otherwise indicated in the drawings, shall consist of a special grade of concrete, mixed in proportions, by volume, of approximately 1 of cement, 1½ of sand and 2½ of coarse aggregate, the latter to be composed of fragments of granite, trap or other suitable igneous rock approved by the engineer. Such coarse aggregate shall pass through a screen having 1-in. round holes and be retained on a ¼-in. mesh screen. No large stones shall be placed in this class of concrete. As maximum possible density and exceptionally smooth and uniform interior surfaces are essential for the conduit linings, more than ordinary care shall be exercised in building, finishing and securing forms and in proportioning, mixing and placing the concrete, and the contractor shall employ none but skilled labor for this work. Both the fine and the coarse aggregates shall be especially well graded. To secure the proper gradation it may be necessary to separate the coarse aggregate into not more than three sizes and thoroughly remix in such proportions as directed. After placing in the forms, the concrete shall be so manipulated by spading and joggling as to expel entrained air, not only from the concrete, but also from between the face of concrete and the forms. No plastering or patching of concrete surfaces forming the waterway shall be done unless expressly permitted, and if so permitted shall be done in strict accordance with directions. No thin patching or plastering will be permitted, but recesses shall be cut of such shape as to retain the patches and of such depth as to insure their permanency. If required, anchor bolts shall be set in drilled holes, and these and wire mesh or other suitable device embedded in the patch. The contractor shall supply carborundum brick or emery wheels, if necessary, and shall dress all inequalities on the surface of this concrete.

Right To Retain Imperfect Work

In addition to the usual requirement that the contractor must make good defective work irrespective of prior acceptance of this work or material, there is a clause which gives the engineer the right, under certain circumstances, to retain work found to be imperfect. If the imperfect work is not bad enough to require replacement, it may be retained at a reduced price:

0.8 Retaining Imperfect Work—If the contractor shall execute any part of the work defectively, and if the imperfection in the opinion of the engineer shall not be of such magnitude or importance as to necessitate, or be of such nature as to make impracticable or dangerous or undesirable, the removal and reconstruction of the imperfect part, then the engineer shall, with the written approval of the board, have the right to make such deduction as may be just and reasonable from the amounts due or to become due the contractor, instead of requiring the imperfect part to be removed and reconstructed.

For example, suppose that a contract for one of the dams be entirely completed at the close of a working season, except that the grassing of the slopes under the item Surface Dressing and Grassing had resulted in a poor stand of grass on a portion of the area. To insist that the contractor correct this imperfection would impose a great hardship on him, as it would mean holding the contract open through the winter and for several months into the following working season. Under the clause quoted, the board could make reasonable deduction for the unsatisfactory grassing, pay the final estimate and close up the contract, attending to the reseeding later at a suitable season. The value of such a clause, under these circumstances, is obvious. It simplifies the carrying out of businesslike methods in many similar instances.

A Few Additional Businesslike Provisions

A remarkable provision that looks to the interests of both parties is made in connection with earthwork for roads. This provision reads as follows:

19.6
20.6
21.6 Readjusting Grades—Attention is called to the uncertainty of ledge-rock elevations, which, owing to the nature of the work to be done, cannot be determined in advance. In order to avoid shallow rock excavation, or to obtain sufficient suitable materials for embankments and refills, or for any other purposes, the grades shown on the drawings may be changed or modified at any time by the engineer to obtain the desired results.

The intent to facilitate rather than bind and hamper the contractor is seen in the following paragraph:

Wherever in the specifications or in the drawings standard specifications or other publications are referred to, copies thereof may be found, available for reference, at the office of the chief engineer.

Also, in the following:

In the event of any doubt as to the meaning of any portion of the contract, specifications, drawings, supplementary drawings or instructions of the engineer, the same shall be understood to call for the best types of construction, both as to materials and workmanship, which reasonably can be interpreted.

The contractor is also helped by an important provision in the section governing the procedure in making the final payment. Final payment is to be made by the district before the expiration of 30 days from date of final acceptance by the board, irrespective of claims against the district, provided the contractor submits a detailed list and statement concerning any such claims. In other words, the payment is not held up until all claims are

adjusted, but only until data are submitted by which their adjustment can subsequently be taken up.

The contractor receives interest at 6% on all delayed payments, interest beginning on the tenth day after date of estimate, or in case of the final payment, on the thirtieth day after acceptance of the work by the board.

Authors of the Specifications

The specifications as finally adopted represent largely the work of Arthur E. Morgan, Chief Engineer, and Charles H. Paul, Assistant Chief Engineer; H. S. R. McCurdy also had an active part in their preparation; but the unusual variety of previous experience represented by the large number of engineers engaged upon this project enabled special first-hand knowledge to be utilized on all sections of the specifications. Among those contributing in an important way to the final result are Daniel W. Mead, consulting engineer; J. H. Kimball, O. N. Floyd, G. H. Matthes, Walter M. Smith and A. B. Mayhew. The specifications and form were searchingly reviewed from a legal viewpoint by the attorneys for the district, E. J. B. Schubring, of Madison, Wis., O. B. Brown and John A. McMahon, of Dayton, Ohio.

Evolution of the Flood-Control Project

Immediately after the disastrous flood of March, 1913, a Flood Prevention Committee composed of leading citizens of Dayton, Ohio, began a consideration of ways and means of preventing the recurrence of such a disaster. They employed the Morgan Engineering Co., of Memphis, Tenn., to make all necessary engineering investigations and suggest a plan of procedure. Upon the recommendation of this company, a plan of protection for the whole valley was adopted, a new enabling law was passed by the State Legislature, and under this new law the Miami Conservancy district was established in July, 1915, with its office at Dayton. The directors of the district are E. A. Deeds, of Dayton; Henry M. Allen, of Troy, and Gordon S. Rentschler, of Hamilton. The secretary of the district is Ezra M. Kuhns.

Previous to the legal organization of the district much of the preliminary investigation and general planning was completed, and immediately upon its creation the district took over the whole engineering organization and has carried forward the work to date. As soon as the legal procedure required in the levying of the special assessments against the benefited property can be completed it is expected that contracts will be let and the whole project pushed to rapid completion.

Earth Roads by Day Labor

The building of earth roads by day labor in Jackson County, Minnesota, was decided upon by the County Board in the winter of 1915-16. W. M. Richmond, District Engineer of the State Highway Commission, acted as superintendent and had charge of hiring the men and teams, purchasing the camp equipment, etc.

The equipment was purchased early in the spring of 1916. This included two horse or stable tents 30x24 ft., a dining tent 19x19 ft., a bunk tent 28x18 ft. and an office tent 14x16 ft. There was also the kitchen equipment and sleeping equipment for a camp of 30 men. The kitchen was built of lumber and made in sections put together with hooks and bolts, so as to be easily assembled and moved. The county leased from a railway contractor 18 teams, equipped with harness, at $35 per month, the owner to stand all risks of injury and death. These teams were in service about seven months. No other outfit had to be hired, as the county has its own elevating grader, 10 dump wagons, a 13-ton traction engine and two road graders (or blade machines), also about 12 wheeled scrapers, 12 fresno scrapers and 4 slip scrapers.

The grading outfit consisted of the elevating grader and mormon teams, a dumpman and six to ten wagon teams, depending upon the length of haul. A foreman had charge of this outfit and of the entire camp. The turnpiking or finishing outfit (under the same foreman) included the traction engine, two blade machines and four men. There was also one laborer to remove rock and stones from the road, to throw off any excess sod and to clean out the ends of ditches and culverts that this work covered up.

The culvert crew consisted of a strawboss and four to six laborers, as the work required. This gang also looked after all side ditching and clearing and grubbing of trees. Two teams were used generally to haul the culverts from towns, but when there was a long haul to be made on the road they would go on the grading outfit. Sectional concrete pipe culverts are used for crossing the road, and corrugated metal culverts are used in the farm driveways. The road culverts were installed ahead of the grading outfit, and the others were placed after the blade machines had finished their work.

The turnpiking or finishing crew followed as closely as possible behind the grading outfit, and it was seldom that a mile of graded work was left unfinished. Sometimes the engine and road graders would go ahead and do about a ¼ mi. of finishing while the grading crew were working on a mile stretch, but as soon as this stretch was graded and clear of the outfit the finishing crew would go over it, cleaning up the ditches and shaping the road to the proper crown. In this way each mile of road was opened for travel as the work progressed.

During the 1916 season, over 100,000 cu.yd. of earth was moved with the grading outfit, while the blade-machine outfit did 6 mi. of turnpiking besides all the finishing. For a month early in the season, the engine and blade machines went over the roads already built, clearing out the side ditches and reshaping the top surface.

The men were paid by the month, with board added, except that the laborers were hired by the day. The cook was allowed $5 per week per man, with use of the kitchen and equipment free of charge. He made good pay by boarding the men at this rate, as his only expenses were for coal and food. All of the crews noted above worked 10-hr. shifts.

During 1916 there were 26 mi. of earth road built. They are 24 ft. wide or 38 ft. c. to c. of ditches. The country is rolling, and the roads have maximum grades of 5%. The estimated cost was $1318, but the actual cost was only $1206. The work has proved satisfactory both to the County Board and to the people. It is proposed to build 38 mi. in the same way in 1917 and to finish up in 1918 all the present designated state roads in the county. After all the roads are graded, the county will turn to the work of graveling them, beginning with those which were first graded.

Presidents of Four of the National Engineering Societies

[WITH PORTRAITS]

SYNOPSIS—Following the annual custom of "Engineering News," now of 24 years' standing, there are published herewith portraits and brief biographies of the presidents of four national engineering societies. The group is this year completed by inclusion of the President of the American Railway Engineering Association in place of the President of the American Institute of Mining Engineers, who will not be elected until later in the month.

George Herndon Pegram; American Society of Civil Engineers

By Richard S. Buck*

George Herndon Pegram was born at Council Bluffs, Iowa, Dec. 29, 1855, the son of Capt. Benjamin Rush Pegram and Mercy Adelaide Robbins Pegram. Captain Pegram subsequently lived in St. Louis, Mo., and was the head of a large steamboat company on the Mississippi River during the Civil War and for some years thereafter, when steamboating on the Mississippi was at its zenith.

Captain Pegram's family, one of the large and well-known Virginia families, originally settled in Dinwiddie County in early colonial days and has since then been liberally represented among notable Americans and especially in all the wars of this country. Edward Pegram, great-great-grandfather of George H. Pegram, commanded a company in the Revolutionary Army. John Pegram, his great-grandfather, was during the War of 1812, a major-general in the volunteer forces of Virginia. During the Civil War two generals, a naval commander and several in minor commands represented the Pegram family in the Confederate forces. On the maternal side, Mr. Pegram's family lived for many generations in Barnstable County, Massachusetts. Richard Sears, a direct progenitor, settled in Plymouth in 1630. Mr. Pegram's maternal great-grandfather served under Washington, and his mother's father fought in the War of 1812.

George H. Pegram was graduated from Washington University, St. Louis, Mo., in 1877, standing at the head of his class. On graduation he entered upon active professional work, becoming one of the engineers engaged in the construction of the Utah & Northern Ry., of Idaho. In the following year he was appointed chief assistant engineer to C. Shaler Smith, one of the most noted of bridge engineers. Two years later he became chief engineer of the Edge Moor Bridge Co. He occupied this position until 1886, when he resigned and made a tour of Europe, having long determined that when he reached the age of 30 he would lay aside all business and devote at least a year to travel, study and recreation.

On his return from Europe he established himself as a consulting engineer in New York City. In 1889 he became consulting engineer of the Missouri Pacific Ry., but resigned this position in 1893 to become chief engineer of the Union Pacific System. During the construction of the plants of the Pioneer Electric Power Co., of Ogden and Salt Lake City, he was also consulting engineer of that corporation.

He became chief engineer of the Manhattan Elevated Ry., New York City, in 1898 and later of its successor, the Interborough Rapid Transit Co.; also of the Rapid Transit Subway Construction Co. in 1905, and of the New York Railways Co. in 1912, which positions he still holds.

He designed and effected the very extensive reinforcement of practically all the old Manhattan elevated-railway structures, which has deferred indefinitely their renewal. He designed and built the third-tracking work of the Manhattan elevated system; and as chief engineer for the contractor, he had charge of the construction of the East River tunnel between the Battery and Brooklyn Borough Hall, and of six sections of the new subways, including the loop under Battery Park and the Diagonal Station at 42nd St. and Park Ave.

This work of construction and reconstruction of the New York transit lines has rarely included anything striking or spectacular from the point of view of the casual observer; but no engineering enterprise ever undertaken has perhaps contained such a multiplicity of complex problems, nor more serious elements of danger, which could be successfully met only by the highest order of engineering skill and sleepless vigilance. Notwithstanding this and the further fact that the enormous traffic of the system has had to be constantly maintained, often under most trying conditions, no serious accident involving injury or loss of life to the public has been attributable to the work under Mr. Pegram's charge.

While Mr. Pegram's *magnum opus* has been in connection with the New York transit systems, many other notable works have been performed by him, such as the invention of the Pegram truss, the design of the Kansas City Elevated R.R., the design and construction of the combined highway and railway bridge over the Arkansas River at Fort Smith, and the design of the trainshed of the Union Station at St. Louis.

Mr. Pegram is a past-president of the Technical Society of Omaha and of the Alumni Association of Washington University, which institution in 1905 bestowed on him the honorary degree of master of arts. He has been a director and vice-president of the American Society of Civil Engineers and has served on important special committees of that society. He is a member of the Engineers' Club and of the Railroad Club, of New York City.

Mr. Pegram was married on Sept. 8, 1897, to Miss Jessie Merrielees Crawford, daughter of Dugald Crawford, of St. Louis, Mo.

Despite the many and exacting duties of his position, Mr. Pegram has maintained an active and effective interest in general engineering development and has a broad and pleasant circle of professional and social acquaintances.

*Consulting Engineer, New York City.

PRESIDENT OF THE AMERICAN SOCIETY
OF MECHANICAL ENGINEERS

PRESIDENT OF THE AMERICAN SOCIETY
OF CIVIL ENGINEERS

PRESIDENT OF THE AMERICAN RAILWAY
ENGINEERING ASSOCIATION

PRESIDENT OF THE AMERICAN INSTITUTE
OF ELECTRICAL ENGINEERS

THE PRESIDENTS OF FOUR GREAT NATIONAL ENGINEERING SOCIETIES

Ira Nelson Hollis; American Society of Mechanical Engineers

By M. E. Cooley*

"Brotherhood of all engineers and their united action in any service that will be for the good of our country"—a splendid motto, worthy and characteristic of the new president of the American Society of Mechanical Engineers. With the anticipated coöperation of the presidents of other national societies, engineers may be expected to behold their profession in a broader aspect and in a new relation to the world which they serve. And with their characteristic energy they may speedily create for themselves a field of greater usefulness with corresponding prestige and emoluments. To such a prayer all engineers will say Amen!

March 7, 1856, and Mooresville, Ind., among low mountains called the "Knobs," were the time and place of the birth of Ira N. Hollis. New Albany, six miles away, was his home from 1858 to 1868. The family then moved to Louisville, Ky. The Hollises, originally English, moved from Berkeley County, Virginia, to Jefferson County, Kentucky, soon after the Revolution. Lewis, Ira N. Hollis' grandfather, had 19 children, all of whom grew up; and Ephraim J., his father, had four, a son and three daughters. The grandfather fought in the battle of Tippecanoe, and the father served four years as an officer in the Civil War, ending in Sherman's march to the sea. His mother, Mary Kerns, also of English origin, moved into Ohio from Pennsylvania. She was the daughter of the contractor who built the Ohio & Mississippi (now Baltimore & Ohio) R.R., west of Seymour, Ind.

Starting in a private school in New Albany, Hollis continued his education in the grammar and high schools of Louisville. In his senior year he won the second of the two gold medals given by the city for high scholarship. Louis D. Brandeis, now a justice of the United States Supreme Court, won the first. Obliged to go to work, he was apprenticed to Webster's machine shop and foundry in New Albany, where river-steamboat engines were built. Health failing after a year, he found lighter employment as a clerk on the transfer platform of the Louisville & Nashville R.R. freight depot in Louisville. Six months later he went to Memphis as bookkeeper in a cotton commission house.

It was in the spring of 1874, when at the age of 18, that Hollis saw a way open to complete his education. The four-year course for engineers had just been established at the United States Naval Academy, to which 25 cadets were to be appointed annually on competitive examination. Thomas Scott, president of the Pennsylvania R.R., furnished him a pass to Annapolis and return, and Mr. Keane, manager of the Louisville Hotel, financed him for the trip.

Turned away on arrival at the academy for want of credentials, he proceeded to Washington, where, watching his opportunity, he appeared unannounced before the Secretary of the Navy. An hour's talk with the secretary sufficed to secure a permit, armed with which Hollis returned to Annapolis and took the examination with 75 others from all sections of the country. This was early in September.

It was a disheartened boy who returned home after the examinations, fearing he had failed miserably. There had been little time to prepare except on the train, and physics had not been included in his high-school course. Imagine his surprise a few days later to receive orders to report at Annapolis on Oct. 1, and his joy on arrival to find that he had passed No. 1.

At Annapolis, Hollis early took the lead, which he maintained, and graduated No. 1 in 1878. Not only that, but he found time to pursue advanced courses in several subjects and did considerable reading. In his first class year he was appointed chief cadet officer of the Engineer Division. His interest in athletics was such that, had his strength permitted, he would gladly have shared scholarship with physical prowess. Desiring to follow naval architecture, he applied for orders to go abroad for study, but the department's policy in this regard was not established until the following year. Then and for many years thereafter the two graduates with highest standing received the coveted honor.

On Sept. 20, 1878, Hollis reported for duty on the "Quinnebaug," fitting out at the Norfolk navy yard. She was to cruise in European waters, if on her trial trip she made 14 knots. Her 10 boilers of the "powder keg" type, built for 80 lb. pressure, were among the first steel boilers in the navy. Her engines, originally low pressure, had been compounded by bushing one of the cylinders, but the copper piping had for the most part been left unchanged.

In assigning stations among the four watch officers in the Engineer Division the boilers fell to Hollis. That trial trip with its foaming boilers and squirting feed pipes was a nightmare, but the ship went to Europe. She sailed without Hollis, however, who was detained in the naval hospital with typhoid and joined the ship later at Malaga. This cruise lasted 28 months. His next cruise, of 19 months, was on the "Hartford," starting in June, 1885. He served on the "Charleston" 26 months, from December, 1889, his last sea service being three months on the "Richmond."

On returning from Europe, Hollis was ordered, Sept. 2, 1881, to Union College, Schenectady, N. Y., where he served for 34 months as professor of mechanical engineering under the Act of 1879, which authorized the detail of engineer officers of the navy to colleges to teach steam engineering and iron-ship building. His next shore duty was with the Navy Advisory Board for nine months, from June 30, 1884, during the building of the White Squadron.

He was on inspection duty for 30 months, from Apr. 15, 1887, in San Francisco, while the "Charleston" was being built at the Union Iron Works. Following his cruise in the "Charleston," he was ordered to the Bureau of Steam Engineering in August, 1892, where he served for one year. In October he delivered a course of lectures at the Naval War College, Newport, R. I., on "Coal Endurance and Machinery of the New Cruisers," later published in the *Journal* of the American Society of Naval Engineers (Vol. IV, No. 4). He resigned, Sept. 30, 1893, to accept the professorship of engineering at Harvard University.

Graduating as a cadet engineer, Hollis was promoted to assistant engineer, June 20, 1880, and to passed as-

*Dean of the Colleges of Engineering and Architecture, University of Michigan, Ann Arbor, Mich.

sistant engineer, at the age of 33, Feb. 19, 1889. It had taken 11½ years to reach the grade of junior lieutenant, a discouraging prospect for young men.

At least twice Hollis may be said to have rendered notable service to the navy. The first was connected with the filibuster "Itata" during the Chilean insurrection in 1891. After her chase by the "Charleston" and surrender in Iquique, a board of survey set a time limit of from six to eight weeks to put her machinery in order to return to San Diego. Hollis, assisted by two other officers and 50 men from the "San Francisco," "Baltimore" and "Charleston," did the work in five days and then brought the "Itata" north without stop at an average speed of 8¾ knots. This accomplishment brought a very complimentary letter from Admiral McCann to the Navy Department. An interesting account of the "Chase of the Itata" was published in the *Journal* of the American Society of Naval Engineers (Vol. IV., p. 360).

But his greatest service to the navy was as a civilian. It had to do with the Personnel Bill, enacted into law Mar. 3, 1899. It ended the line and staff fight of many years' standing. In the early summer of 1897 Professor Hollis, on being asked to contribute to the fund for carrying on the fight in Congress, went to Washington and proposed a plan to Secretary of the Navy Long, which led to the appointment of the Personnel Board, with Colonel Roosevelt, then Assistant Secretary of the Navy, as chairman.

The important features of the plan were: (1) The amalgamation of the line and engineers; (2) the selection of engineers from the line to do engineering duty and to remain as a technical corps; (3) regulation of the flow of promotion; (4) some kind of general staff. There were some 13 points in all. The subject will be found treated quite fully in the *Atlantic Monthly* for September, 1897, and in the *Army and Navy Journal* from Aug. 21 on.

Secretary Long reported favorably to Congress, Jan. 13, 1898; the bill passed the House, Jan. 18, 1899, and the Senate, Feb. 17. Two features advocated by Professor Hollis were omitted—namely, the technical corps and the general staff. But these have since been formed, or are about to be. Notwithstanding his important part in this reorganization work, Professor Hollis would not wish it understood that he did more than help start it and assist when called on in perfecting the bill then being drawn up.

During his 20 years at Harvard, Professor Hollis accomplished many things. An interesting account of them will be found in the *Harvard Magazine* for June, 1913. He took a prominent part in the life of the college and was highly esteemed. The attendance in engineering increased many fold. Largely through his efforts Pierce Hall and its equipment were provided in 1901, and the summer school at Squam Lake, N. H. The Harvard Union and the stadium became realities largely through his efforts. For eight years, from the fall of 1895, six as chairman, he served on the Athletic Committee. Sports were moved from Holmes Field to a new site created out of tide-washed barrens. This became Soldier's Field, now most completely equipped for every branch of college athletics.

It was while Professor Hollis was on the Athletic Committee that a scholarship requirement was imposed on all who would engage in intercollegiate games. This restriction took practical form in the joint rules between Harvard and Yale, which because of keen rivalry required two years for their enactment.

Professor Hollis' work at Harvard was largely constructive. Long-established conventions had to be faced, and it was only by his admirable tact that he handled successfully many problems bound about by traditional red tape. His strong character and keen sense of right and wrong have, by long years of discipline tempered by a quick appreciation of humor, made him unusually effective. Those who have been his colleagues and students testify abundantly to his remarkably fruitful life while there.

He was offered and accepted the presidency of Worcester Polytechnic Institute in 1913. Already in his three years at Worcester he has established himself in the affections alike of its governing board, faculty and student body.

President Hollis holds the honorary degrees of A.M., from Harvard, 1899; L.H.D., from Union, 1899; and Sc.D., from Pittsburgh, 1912. He is a fellow of the American Academy of Arts and Sciences and a member of the American Society of Naval Engineers, American Society of Naval Architects and Marine Engineers, Boston Society of Civil Engineers and the Society for the Promotion of Engineering Education. He is the author of "War College Lectures," 1892; "History of the Frigate 'Constitution'," 1900; and has been a liberal contributor to engineering journals and various other publications.

He was married Aug. 22, 1894, to Caroline Lorman of Detroit, a graduate of the University of Michigan. They have four children: Jannette Ralston, a senior at Bryn Mawr; Oliver Nelson, a senior at Harvard; Elinor Vernon, soon to enter Vassar; and Carolyn.

Harold Winthrop Buck; American Institute of Electrical Engineers

By W. L. R. Emmet*

Harold Winthrop Buck comes of a family very well known in New York. He is the son of Albert H. Buck, a well-known surgeon and artist in New York; and his grandfather, Gurdon Buck, was also a surgeon, famous in his time. His mother, Laura Abbott Buck, is a member of a distinguished New England family; her father was John S. C. Abbott, the well known historian.

Harold W. Buck was born on May 7, 1873. He inherited a good constitution, and he has developed it by a love of outdoor life. He was graduated at Yale University with the degree of bachelor of philosophy in 1894 and from Columbia University in 1895, with the degree of electrical engineer.

His first engineering work was with the General Electric Co., at Schenectady, where he began as a student in the testing department in 1895. During his two years of apprenticeship he showed originality in several matters, which attracted attention. He was associated with two others in the invention of a method for making in an electric furnace, from clay, an abrasive that was

*Consulting Engineer, General Electric Co., Schenectady, N. Y.

equivalent to corundum or emery. This process was sold to the Norton Emery Co., of Worcester, Mass., and with certain developments and modifications has grown into a very important industry.

In 1897 he became assistant to the writer, then engineer of the lighting department of the General Electric Co. At that time an active campaign was being carried on in Schenectady for the introduction of alternating current for general distribution. The uses of alternating current before that time were very primitive, and its adoption in large parallel operating systems involved a very rapid and extensive development of inventions, designs and constructions. This campaign involved the expenditure of great sums for radically new apparatus of many types and many operating problems that had not been encountered before. It was carried through within two or three years without important mistakes and constituted a noteworthy step in the great electrical development. Mr. Buck was in the thick of this campaign and rendered fine service in it. He had a good mental grasp of the situation and had the courage to do things when many others had not.

As a result of his activities during this critical time Mr. Buck was, in 1900, notwithstanding his youth, recommended for the important position of chief engineer of the Niagara Falls Power Co., which was then in the most important and active stage of its development. This position covered also the electrical engineering for the many allied interests, including the Canadian Niagara Power Co., which was then just beginning its development, and the Power and Conduit Co., of Buffalo. Mr. Buck held this position until 1907 and during that period was intimately associated with the many interesting electrical activities of that most remarkable industrial district.

In 1907, in association with M. A. Viele and F. O. Blackwell, Mr. Buck joined the corporation of Viele, Blackwell & Buck, consulting engineers, New York City, of which he is vice-president. From its inception the corporation has played an important part in the design and construction of many famous power developments both in the United States and Canada, including such systems as the Great Western Power Co., the Appalachian Power Co., Schenectady Power Co., East Creek Electric Light and Power Co., the Northern Ontario Light and Power Co., Northern Canada Power Co., the California Electric Generating Co., and others of equal importance.

In addition to his activities as vice-president of Viele, Blackwell & Buck, Mr. Buck is also connected with the General Utilities Corporation. He has taken out patents on a number of useful electrical devices and, in conjunction with E. M. Hewlett, developed and introduced the suspension-insulator system now in general use on most high-tension transmission lines, it being indeed the key to successful operation with the voltages now used.

Mr. Buck has written extensively upon engineering and electrical subjects for technical publications, and he is author of a number of papers which are to be found in the *Proceedings* of the American Institute of Electrical Engineers.

Mr. Buck was married in 1902 to Miss Charlotte R. Porter, of Niagara Falls, a daughter of a distinguished family whose name has been associated with Niagara Falls from an early day.

A. Stuart Baldwin; American Railway Engineering Association

By Isham Randolph*

A winning combination in this world is that of character, brains, experience and pleasing personality—with few exceptions it means success.

Inheritance gave Archibald Stuart Baldwin the brains; precept and high example formed his character; pursuit of his chosen profession through more years than, perhaps, he is willing to own up to, brought him the ripe experience that makes his judgment worth while; and innate courtesy and kindness have endowed his pleasing address.

His engineering experience began as an axman. But he was capable of better things than clearing a path through the underbrush and making, toting and driving stakes. His party chief soon found it out and varied the monotony of existence by having his axman rest himself in the evenings, making computations, profiles and doing other odd jobs not ordinarily in the axman curriculum.

The head chainman of this survey party was a mountaineer who had worked with surveying parties for a long time and had acquired rare ability as a natural locator of railroad routes in rough country. When he parted with young Baldwin, the mountaineer expressed his pleasure at Baldwin's having obtained a better job and proceeded to counsel him, saying, "So many engineers fall down when they try to do things they can't do; don't you never do that again; don't you never try to be an axman again; don't you never try to do nothin' you can't do."

Mr. Baldwin has kept that advice. He has never tried to "do nothin' that he can't do." He has been doing things that he could do and doing them so well that his advancement has been from responsibility to responsibility, until today he is chief engineer of the Illinois Central R.R.—and he has never had any pull, nor has he made stepping stones of his fellowmen. His accomplished work, wherever he has been, has created the steps by which he has mounted to responsibility, respect and esteem.

He was born in Winchester, Va., Sept. 28, 1861—one might say in the very midst of the Civil War country. His father was Dr. Robert F. Baldwin. After a good elementary education at the Shenandoah Valley Academy, Winchester, and at the Staunton Military Academy, Staunton, Va., A. Stuart Baldwin started in 1879 to learn civil engineering with the engineer corps of the Richmond & Allegheny R.R. (now a part of the Chesapeake & Ohio Ry.).

From the position of rodman with the railway company he stepped to that of assistant engineer and subsequently engineer of the Iron and Steel Works Association of Virginia. In 1882 he returned to railway work as a draftsman and assistant engineer with the Baltimore & Ohio R.R. on the Philadelphia extension. During 1885 and 1886 he was principal assistant engineer of the Missouri River bridge of the Chicago, Milwaukee & St. Paul Ry., at Kansas City, Mo. Then for a time he was resident engineer of the Louisville, St. Louis & Nashville R.R.

*Consulting Engineer, Chicago, Ill.

In 1887 he began 11 years of service with the Louisville & Nashville R.R., during which time he was assistant engineer and later roadmaster. The Illinois Central R.R. obtained his services in 1901 as principal assistant engineer. He was soon after made engineer of construction, and since 1905 he has been chief engineer.

Mr. Baldwin is a member of the American Society of Civil Engineers, Western Society of Engineers, Chicago Engineers Club and of the Society of Cincinnati of Virginia. He married Miss Mattie Frazier, of Staunton, Va., Dec. 19, 1883.

Concrete Bridges with Through Arches

Two reinforced-concrete arch bridges built recently in Illinois are of the Marsh "rainbow-arch" type, having through spans in which the deck is above the level of the spring line, while its middle portion is suspended from the arches. One of these bridges is over the Fox River, near Crystal Lake, Ill., and the other is over the Little Wabash River, at Carmi, Ill.

The special feature of this type of concrete bridge is that it permits longitudinal expansion and contraction movements of the deck without affecting the arches. This is provided for by making the deck slab independent of the arch ribs at the two points where its plane intersects them and supporting it at each of these points upon a cross-girder or floorbeam built integrally with the arches. The floor slab is practically monolithic, but has a chance to deflect between the floorbeams, as there is a construction joint over the center of each beam and the reinforcing in the top of the slab does not extend over the beams, although the lower reinforcing is continuous.

The design is considered to be economical and is of particular advantage where the headway is insufficient for a deck-arch bridge or where the flood line approaches to the level of the bridge floor. This type of bridge is the invention of J. B. Marsh, of Des Moines, Iowa, and was patented by him in 1912. He is represented in Illinois and other central states by the Westcott Engineering Co., of Chicago, and this company was associated with him in the design of the two bridges noted above. Both bridges were built by the J. J. O'Heron Co., of Chicago.

The Crystal Lake bridge has five spans with a clear distance of 80 ft. between piers. It carries a roadway 18 ft. wide. The arches are segmental, with a rise of 16 ft. and a radius of 58 ft. on the lower side. Each rib is 22 in. wide, with a depth of 26 in. at the crown and 35 in. at the floor intersection. They are spaced 18 ft. apart in the clear. The steel reinforcement in each arch is a box-lattice girder composed of four flange angles with lacing bars on all four sides. To this girder are attached the hangers (composed of four angles) the lower ends of which are connected by pairs of transverse angles embedded in the floorbeams. At the ends the arch thrust is taken by the side walls of the hollow abutments, but at the piers the steel ribs of adjacent spans are connected so as to form a continuous structure.

The end floorbeams are built into the arch ribs and are integral with them. The deck of each span is a 7-in. slab, built integrally with the intermediate floorbeams (carried by the hangers), but independently of the end floorbeams and abutments (or piers). Thus the slab can move horizontally without any effect upon the movements of the ribs. Each pier consists of a pair of pedestals connected by a curtain wall. The abutments are of hollow box form, with transverse struts. Pile foundations are used, the ground being gravel and clay. This bridge was built in 1915 and 1916 and cost about $20,000.

FIG. 1. RAINBOW-ARCH CONCRETE BRIDGE AT CARMI, ILL.

The Carmi bridge has three arch spans of 90 ft. between piers, with a rise of 18 ft. and a radius of 65 ft. 3 in. on the under side. It has an 18-ft. roadway and 6-ft. sidewalk between the arches. The bridge is high, with its deck 43 ft. above the bed of the stream. The Little Wabash River is subject to very sudden rises, the water level rising sometimes 40 ft. in three days after a heavy rain. The rainbow type of through-arch span is of particular advantage under such conditions, as it gives a maximum clearance for the waterway and does not cause such obstruction (to drift and water) as would be caused by a deck-arch span. This bridge was built in 1916 and cost about $21,960.

The method of construction of the rainbow-arch bridges is to place the structural steel reinforcing of the

FIG. 3. FALSEWORK FOR CARMI BRIDGE

ribs first and connect them rigidly in place with struts, floorbeams and hangers. The formwork is then built around the steel reinforcing. The reinforcing for the arched ribs is composed of four angles laced on four sides and with the back of the angles placed outward, which gives the maximum value for the metal. The angles can be made heavy enough to carry the forms and the formwork of the bridge, including the weight of the concrete. Where this method will be cheaper than to support the structure on piles in the bed of the river, it is not necessary to put in piles and supporting falsework at all, so that after the piers are built there is no danger from floods washing out the falsework and carrying away the bridge during construction.

The concrete in each case was a 1:2:4 mix, using gravel with a maximum size of 1¼ in. The forms were of wood, except for the parapet walls. For these latter, special pressed-steel forms for balusters were used in combination with wood forms for the base and cap. These forms were built up in sections to fit and were used repeatedly. The concrete was then poured in place. The mix was 1:1½:3, with the coarse aggregate ½ in. in size. The rail required no special treatment or finish after the forms were removed. No surface treatment was employed to remove form marks, etc.; but where necessary to improve the appearance, the surfaces of the arch ribs, posts or piers were rubbed to an even finish.

The bridges were designed for a live-load of 125 lb. per sq.ft. on the roadway and sidewalk, and the floor system for a 20-ton road roller, according to the standard specification of the Illinois State Highway Department. The stresses in concrete were what governed, as the load carried by the steel does not exceed 16,000 lb. per sq.in.

The rainbow-arch designs for these two bridges were placed in competition with the design prepared by the State Highway Department, and the bids for these were in competition with those of contractors bidding on the latter designs. In accordance with the Tice Law in Illinois the design had to meet the approval of the State Highway Department and had to be of sufficient strength to carry the loading provided for in the department's specifications.

Water Meters and Meter Rates in San Francisco, Calif., have been the subject of much commotion of late. It appears that the Spring Valley Water Co. began a rapid extension of its meter system on July 1, 1916, with the intention of setting 25,000 meters on residence services within a year. Subsequently, it began to bill for metered water at the rates fixed by the San Francisco Board of Supervisors (city council) on June 29, 1915. Since then the control of water rates in San Francisco has been vested in the State Railroad Commission. Allegations that the meter rates are excessive brought the matter before the commisison, which seems to have held that the city ordinance did not provide rates for meters on all domestic services and that since the commission had not established meter rates the company was without authority to collect such rates from domestic consumers generally. The commission has just renewed an order, issued in November, directing the company to bill consumers at flat rates, but to read the meters monthly and to notify customers of the readings. This order is to hold until Feb. 1. What is to happen after that date is not clear.

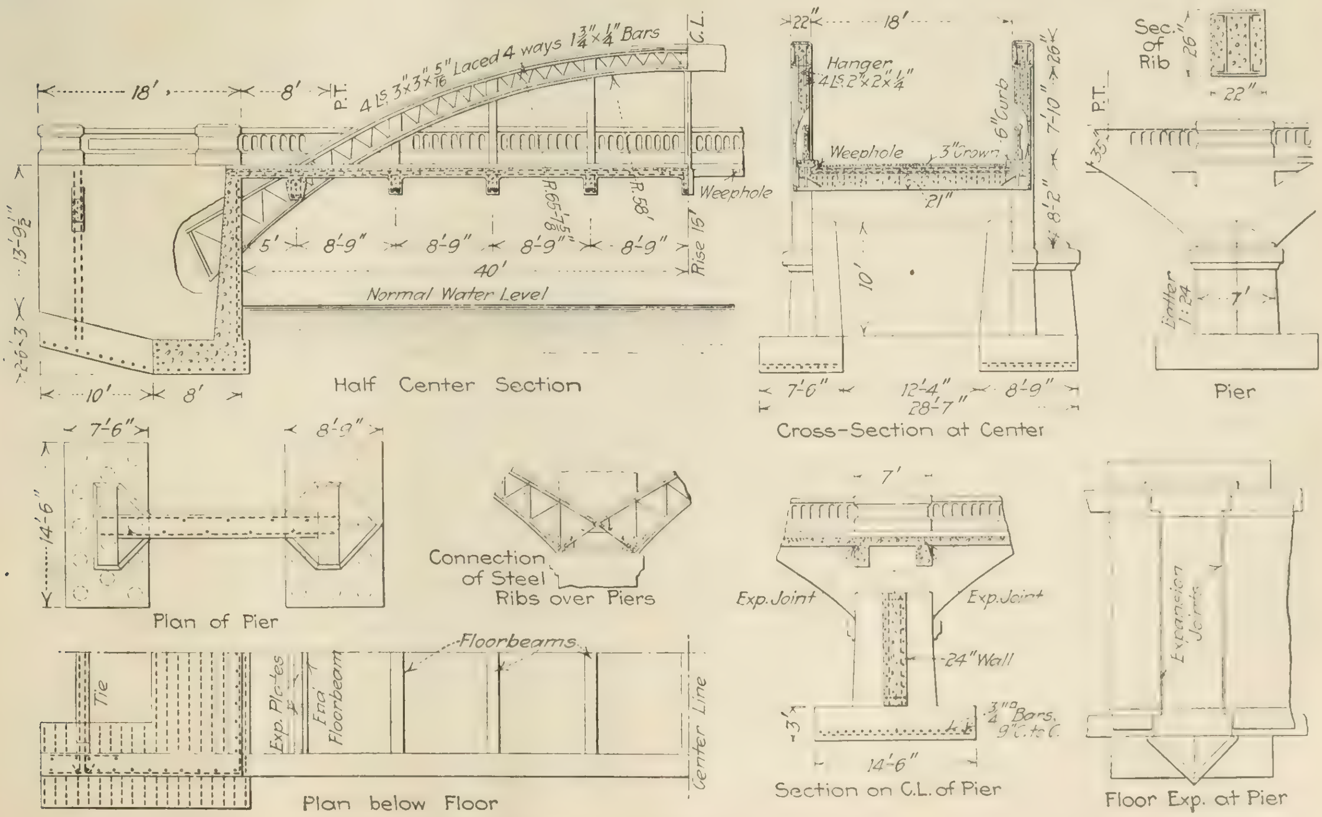


FIG. 2. DETAILS OF RAINBOW-ARCH CONCRETE BRIDGE OVER THE FOX RIVER AT CRYSTAL LAKE, ILL.

Engineering Literature

Merriman's Hydraulics Revised

REVIEWED BY ROBERT E. HORTON*

TREATISE ON HYDRAULICS—By Mansfield Merriman, M. Am. Soc. C. E., with the assistance of Thaddeus Merriman, M. Am. Soc. C. E. Tenth edition, revised. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. x + 565; illustrated. $4 net.

Inasmuch as Merriman's "Treatise on Hydraulics" is widely known and earlier editions have been reviewed in this journal from time to time, a complete review of the text will not now be attempted. The great advances in hydraulics since the publication of the first edition of Merriman's book in 1889 are exemplified in some degree by the growth in the book itself. At the present time there are at least seven leading lines of hydraulic practice, including water-power development, river improvement and navigation, water-supply and purification, drainage and irrigation, sewerage and sewage disposal, naval hydro-mechanics, and pumping and hydraulic machinery. The hydraulic features of each of these subjects receive treatment in Merriman's book to the extent, at least, that the salient facts and principles are briefly set forth.

As pointed out by the late George W. Rafter in his review of the eighth edition of this work (*Engineering News,* June 18, 1903), a distinguishing characteristic of Merriman's "Hydraulics" is lucidity of style. In the tenth edition the practice of presenting a full explanation and less purely mathematical discussion is carried even farther than in earlier editions. The smooth, lucid, easy style gives to the demonstrations of formulas a simplicity and naturalness that is very pleasing—likewise easily forgotten. The demonstrations, while less thorny than those presented in more formal mathematical language, are not lacking in probative force. Easy reading makes the book attractive, both to the average student and to the practicing engineer who wishes to brush up on a knotty problem without at the same time being obliged to refurbish his calculus any more than is necessary. The manner in which the author has succeeded in removing the "demon" from his demonstrations is largely by clear verbal explanation of each step as he proceeds. This has the effect of keeping the hydraulics rather than the mathematics of the subject constantly before the reader.

The criticism that has occurred to the writer in the practical use of several editions of Merriman's book is one common to many textbooks, in that it has been written somewhat too largely from the idealistic standpoint. The use of the term standard as applied to weirs and orifices is unfortunate. Other forms of orifices—for example, those constructed with properly rounded edges—will give results well within the limits of accuracy demanded in practice and at the same time resist ice, débris and hard usage much better than a so-called standard orifice. The practicing engineer is called upon to calculate the flow through hydraulic structures of a wide variety of forms. A young engineer whose training has been academic along these lines is likely to be floored and give up when he first encounters a problem that looks irregular; or if given the results obtained in practical conditions, he is likely to condemn them as worthless.

From the standpoint of the use of the book as a text the conditions are quite different. The textbook sets up principles and ideals to be sought after, even though they may not always be obtainable. It is easier to handle the differences between ideal and practical conditions in the classroom than in a textbook.

Among new features of the present edition are the introduction of Biel's formula for flow in pipes and channels, more modern discussion of the design and practice in relation to the so-called Francis type turbines and a general tendency to broader view and rounding out of subjects in pure hydraulics, which will undoubtedly be found to overcome in some degree the misconception that might arise from the too academical treatment in earlier editions.

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Management and Cost Problems

REVIEWED BY ROSSITER R. POTTER*

INDUSTRIAL LEADERSHIP—By H. L. Gantt. [Addresses delivered in the Page Lecture Series, 1915, before the Senior Class of the Sheffield Scientific School, Yale University.] New Haven, Conn.: Yale University Press. Cloth; 5x8 in.; pp. xii + 128; 6 charts. $1 net, postpaid.

THE PREDETERMINATION OF TRUE COSTS AND RELATIVELY TRUE SELLING PRICES—By Frederic A. Parkhurst, M. E., Organizing Engineer. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. viii + 96; 30 illustrations. $1.25 net.

The five chapters that make up Mr. Gantt's interesting book are taken from a series of lectures given by him before the senior class of the Sheffield Scientific School. The author expresses the belief that through the observance of correct principles a system of industrialism can be developed under the democratic form of government which will be even more effective than anything possible under autocracy. The first chapter sets forth that proper leadership involves consistent remuneration of workmen on a basis of higher pay for more and better work, the elimination of bluff as a factor of business administration, a realization that business administration is simply the administration of human affairs or the handling of men, and selection of industrial leaders by a process that will bring to the front individuals who are really best qualified for such responsibility.

Chapter II, on training workmen, emphasizes the importance of equality of opportunity. In regard to vocational training through the public schools the author believes it preferable for the state to assume responsibility for general industrial training only, leaving the more specific training in a given vocation to the industries themselves. In the latter part of this chapter

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Mr. Gantt slides easily into an exposition of his favorite topic, "task work," which is continued in Chapters III and IV, dealing respectively with the principles and results of this system. Chapter V discusses the relationship of production and sales effort and makes some mention of modern cost-keeping systems. The author approves the plan of charging to the profit-and-loss account as a separate item the daily expense for idle equipment, instead of spreading this expense on the cost of the product and thereby losing sight of its true nature. The book abounds with pithy statements of what are made to appear as self-evident facts, and it should edify any reader interested in modern industrial developments.

Cost-keeping methods are discussed in Mr. Parkhurst's book with particular attention to their use for determining proper selling prices. The first three chapters outline a system for obtaining the information from which the costs are to be ascertained, including the costs of direct labor and material. Special emphasis is laid upon positive control of the sources of information, such as workmen's job tickets. Chapters IV and V take up the problem of indirect costs and their intelligent distribution. The author favors a differential process-rate method for the distribution of burden and agrees with Mr. Gantt in believing that "undistributed burden" should be separately charged to loss and gain.

There is a brief chapter on estimating, which explains the details of a system installed by the author for a company making different kinds of machine tools, dies, etc., and finally a chapter on the different ways of expressing the rate of profit. The author seems to prefer, for general purposes, the basis of profit per productive hour. The author's general method of presenting the subject is by showing typical printed forms and describing their use and purpose. The forms shown apply especially to foundries and to machine shops. The book might be used, by one previously well grounded in the principles of cost keeping, as a guide for arranging the details of a cost system.

Lubricating Oils

REVIEWED BY JOHN J. FLATHER*

LUBRICATING ENGINEERS' HANDBOOK: A Reference Book of Data. Tables and General Information for the Use of Lubricating Engineers, Oil Salesmen, Operating Engineers, Mill and Power-Plant Superintendents and Machinery Designers—By John Rome Battle, B. S. in M. E. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 6x9 in.; pp. 333; 114 illustrations. $4 net.

This book has been written by a mechanical engineer who, as stated in the preface, has been associated with the oil business for a number of years. It consists of an exhaustive compilation of useful data and general information relating to the manufacture, selection and use of oils for lubricating purposes, with especial reference to the needs of oil salesmen, operating engineers, mill and power-plant superintendents, machine designers, purchasing agents and others who may have occasion to use or select oils and greases for lubrication.

The treatment is largely descriptive rather than scientifically technical; and it is to be regretted that so little space is devoted to a most important part of the subject—namely, the chemistry of lubricants—although the author has injected a lot of extraneous material that has little bearing on the subject of lubrication and merely adds to the bulk of the volume.

Among the subjects treated are friction, description and effect; theory of lubrication; petroleum and other lubricants and greases; refining, "cracking" and other processes; oil and grease tests, viscosity, friction-testing machines, steam engines and turbines; electrical-engineering data; lubrication of bearings and steam cylinders; the steam-engine indicator and its use.

The lubrication of a great variety of specific classes of machines is discussed, and in many cases this is accompanied by a description of the machinery under consideration. This includes air compressors, automobiles, Diesel gas engines, baking machinery, coal machinery, electric street cars, passenger and freight elevators, flour-mill machinery, ice-making and refrigerating machinery, internal-combustion engines of the explosive type, marine engines, mining machinery, motors and dynamos, printing machinery, pneumatic tools, railway locomotives and cars, rolling mills, textile machinery, steam turbines, waterwheels and wire drawing.

The cost of lubrication is also discussed, and the subject of purchase by specification is presented all too briefly. In this connection the author states:

> If specifications are desired, they should not be too closely written. Their purpose should be to secure a satisfactory oil for fulfilling certain conditions, at the lowest competitive prices, and should not be written with the view of excluding oils made from crudes, other than that of the tested sample. An exactly stated gravity, viscosity and flash will pin all bidders to very narrow limits. Gravity is of no importance. Lubrication depends upon viscosity and its characteristic variations.

Halsey's Handbook Enlarged

HANDBOOK FOR MACHINE DESIGNERS, SHOPMEN AND DRAFTSMEN—By Frederick A. Halsey, B. M. E., M. Am. Soc. M. E. New York: McGraw-Hill Book Co., Inc. Second edition. Cloth; 9x11 in.; pp. xii + 561; illustrated. $5 net.

The first edition of Mr. Halsey's deskbook (it was not really a handbook) was a prize for all those mechanical engineers who delight in the acquisition of useful data in convenient form; and it was a working companion much appreciated by hundreds of designers. The second edition, of course, is all that and more. The object of the original work was to rescue from comparative oblivion the best of the vast amount of data and suggestions that regularly appear in current mechanical journals. When the first volume was printed, the author noted that the work was incomplete and that he hoped to fill the gaps in subsequent issues.

The appearance of this second edition testifies to the industry of the author and his interested readers, for some 80 topics have either been added or conspicuously expanded. It would be impossible to name them here, but their range is seen from the following: Thrust, knife-edge and roller bearings, strength of spur and herringbone gears, design of skew bevel gears and friction drives, capacity of horizontal cylindrical tanks, discharge of weirs, standard pipe tables, cutting speeds of tools, power consumed by machines, hardness tests, heat-treatment of steel, physical properties of carbon and alloy steels, and various new mathematical tables.

Comparatively little has been dropped. Looking at the book as it stands today, it is seen that the expansion of the title to include shopmen is warranted, though the great wealth of material still will be most appreciated by designers.

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Textbook on Mining

Reviewed by G. M. Butler*

ELEMENTS OF MINING—By George J. Young, M. Am. Inst. M. E. New York. McGraw Hill Book Co. Cloth; 6x9 in.; pp. xiii + 628; 271 illustrations. $5 net.

The author states that his aim has been to give the reader of this book a comprehensive view of mining. In keeping with this aim he has covered every phase of the industry from prospecting, through boring, drilling, rock breaking, transportation and hoisting, mine drainage, ventilation and illumination, support of mine workings, open-pit and alluvial mining, mine development and underground methods; he has even included chapters on mine organization and operation, mine accounting, accidents and miners' diseases and the examination of mineral deposits. In fact, mining law seems to be the only matter affecting the interests of miners that has not been presented.

As a textbook for students this work will probably be favorably received and widely used. In fact, it is doubtful whether any other book on mining covers the subject in quite so satisfactory a fashion. It seems unfortunate, however, that the discussion of mining equipment and of many types of mine machinery has been handled with such brevity. The chapter on transportation and hoisting, for instance, covers but 12 pages, and practically all of the matter there presented is of a theoretical nature. The author justifies the omissions to which reference has just been made by stating that the publishers contemplate issuing a separate book covering the subject of mine equipment; but few instructors or students will view with equanimity the necessity of using two textbooks when one might have been made to serve the purpose as well.

The subjects of rock drilling and breaking, support of mine workings, mine development and underground methods are handled especially well, but one looks in vain for a discussion of the problems encountered in relining shafts.

It is regrettable that data on costs and the amount of work accomplished under typical conditions have not been made more complete, and that where given the sources quoted are often so old as to be almost worthless. For instance, Dr. Henry M. Payne, of New York, in a personal letter dated Jan. 11, states that from his long experience with Keystone drills he would place the average rate of drilling per day at under 10 ft. rather than 10 to 25 ft., as stated at the bottom of p. 35; and that, on an average, it requires 11 cu.ft. of water to move 1 cu.ft. of gravel through sluices, instead of 20 cu.ft. of water, as stated on p. 74. He also writes, in referring to hydraulic mining in Alaska, that the LaGrange costs during the past year were 2½c. per cu.yd., while the Klondike costs were 5c. per cu.yd. This is in strong contrast to the figures given at the bottom of p. 376. He further says that the company with which he is connected is dredging gravel in Alaska at a cost of from 14 to 15c. per cu.yd., which is less than a third of the figures quoted on p. 384.

Outside of the features mentioned, the book is so satisfactory that it seems undesirable to suggest further criticisms of minor details lest an erroneous impression be conveyed. However, a mineralogist will hardly fail to notice that the definition of a mineral, given on p. 1, will apply with equal truth to native gold and a potato.

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Government Highway Literature

Three recent bulletins of the United States Office of Public Roads and Rural Engineering are of interest to highway engineers. One of these is of a more popular nature—"Economic Surveys of County Highway Improvements"—and has received wide publicity in the daily papers throughout the country. It purports to be "a compilation and analysis of data in eight selected counties, showing comparative financial burdens and economic benefits resulting from highway improvement during a period of years." It is consciously or unconsciously an argument for highway improvement and will prove of value to popular good-roads orators in this capacity.

As the basis of estimate for actual highway projects this bulletin must be used with caution. For instance, great stress has been laid on the increase in farm-land values on account of the improved roads, the argument of course being to show that all this increase was derived from highway improvement. This neglects the fact that farm-land values have increased tremendously throughout the length and breadth of the country during the last five years, and this on account of the great increase in the selling price of farm products and the general prosperity of the farmer, as well as on account of improved roads. That farms on the main roads (which are always the ones first improved) should increase in value more and faster than farms on back roads is a foregone conclusion.

The effect of road improvement on land values in Spotsylvania County, Virginia, is arrived at in this wise: A record was kept of the selling values of 35 farms located on improved roads. These show an average increase in five years of 70.2%. To prove that this increase was due to improved roads and not to other causes, three farms "stated by competent authorities to be typical values on unimproved roads" are picked out and the average price quoted to show that this is far below the average of the 35 farms on improved roads! This is typical of the reasoning under this heading throughout the booklet.

It has also been attempted to show the effect of road improvement on traffic development. These data are based largely on statistics of railway freight shipments to and from the several counties, on field observations of average wagon loads before and after road improvement, and on traffic censuses taken infrequently for periods of a week or ten days at a time. From these, tables of annual ton mileage and total saving, on the basis of tonnage hauled after road improvements, have been computed and some impressive figures arrived at, such for instance as $150,000 for the gross annual saving under this head in Spotsylvania County alone. While containing much valuable material for road economists, it is obvious that these figures are arrived at by many broad assumptions that should be most thoroughly investigated and analyzed before applying them generally.

The description of how the roadwork in the various counties was financed and the economic results of those methods of financing form a valuable and instructive part of the booklet, which on the whole is a welcome addition to good-roads literature. While it may fall short of being of any great practical value to the engineer-economist, it is a beginning along a line of

study and investigation that all highway engineers, or for that matter all public-works engineers, will do well to emulate.

The other two bulletins referred to in the opening paragraph are "Methods for the Examination of Bituminous-Road Materials" and "Progress Reports of Experiments in Dust Prevention and Road Preservation." The first is a valuable manual of laboratory practice, and the second an interesting description of the present status of many bituminous-road experiments, most of them in the South.

Heating and Ventilating Buildings

REVIEWED BY D. D. KIMBALL*

MECHANICAL EQUIPMENT OF BUILDINGS: A Reference Book for Engineers and Architects—By Louis Allen Harding, B. S., M. E., M. Am. Soc. M. E.; and Arthur Cutts Willard, S. B., formerly Assistant Professor of Mechanical Engineering, George Washington University, and Sanitary and Heating Engineer, United States War Department. Vol. I: Heating and Ventilating. New York: John Wiley & Sons. Leather; 7x9 in.; pp. 615; illustrated. $4 net.

The authors have produced an admirable text and reference book on the subject of heating and ventilation of buildings. It appears to be the most uptodate and complete book yet published upon this subject. It contains many original and valuable tables and charts and a number of interesting and helpful manufacturers' charts and tables. To quote from the preface:

> The object of the authors is to produce a reference book for engineers and architects which will contain sufficient theoretical and commercial data for use in the designing room, and at the same time serve to show the student of this subject the relation between the theoretical principles involved and their practical application to actual problems.

It would appear that the second object of the book has been reached more fully than in the case of any previous book on this subject, but it is doubtful if the book will find any real place in the designing room, evidencing, as it does, too much of the atmosphere of the laboratory and experimental room and too little of experience in practical designing and construction to serve conveniently in an architect's or engineer's drafting room.

After dealing with heat and its measurement and with water, steam and air, heat transmission, fuels and combustion, the authors take up the various systems of heatting and elements of heating plants. Air conditioning and related subjects are placed between hot-blast and exhaust-steam heating. Central-station or district heating is considered. The final chapter considers equipment cost, plans and specifications.

While dealing fully with the theory of the art, the book falls short, as already stated, on the practical work of the heating and ventilating engineer. The chapter on "Heat Transmission of Building Construction" is most complete and interesting and alone makes the book worth its price. Very interesting also are the discussion and data on inclosed radiators.

In the chapter on "Ventilation, Air Analysis and Ventilation Laws" more emphasis appears to be laid upon the importance of humidity than any scientific data available would seem to warrant, while no mention is made of "air movement," which recent research seems to point toward as a most important factor in ventilation.

Another interesting chapter is that on "Exhaust-Steam Heating." The steam and electric load curves of various types of buildings are valuable. However, the author's estimate of the value of exhaust steam for heating is none too high.

The final chapter ("Plans, Specifications and Cost of Equipment") is much too brief. Even with the limitations noted the book is a good one and should be owned by every engineer and student of heating and ventilation.

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Population Figures

ESTIMATES OF POPULATION OF THE UNITED STATES, 1910-1916, Including Results of the State Enumerations Made in 1915—Washington, D. C.: Department of Commerce, Bureau of the Census. Bulletin 133. Paper; 9x12 in.; pp. 46.

Besides population estimates for the United States and the several states, figures are given for all municipalities having populations of 8000 or more on Apr. 15, 1910. In the tables just named the figures include for each place its land area in acres on July 1, 1915, its United States Census populations on Apr. 15, 1910, and June 1, 1900, and population estimates as of June 1 for each of the seven years from 1910 to 1916 inclusive. In these tables the cities are listed alphabetically by states arranged in the same way. In another table population estimates only for the seven years are given for each place of 25,000 estimated population or more in 1916, the arrangement being from greatest to least. The intercensal state census figures give state and county totals for a number of states for 1915, 1905 and 1895 and corresponding figures for places of 5000 and upward in 1915.

Useful Bridge Information

BRIDGE MANUAL: Containing General Information and Instructions—Prepared under direction of John H. Lewis, State Engineer. Salem, Ore.: State Highway Commission Bulletin No. 3. Paper; 5x7 in.; pp. 154; illustrated.

While intended primarily for the use of the county courts in Oregon in all matters pertaining to construction, maintenance and repair of bridges and culverts, this manual, according to its preface, has been prepared for distribution to various county roadmasters, surveyors, supervisors, etc., in an effort to standardize somewhat the practice throughout the state in the construction of bridges and culverts.

The execution of the project is admirable. It should be useful not only to the persons named, but it should also be of great assistance to bridge engineers everywhere. While of course there is much of purely local interest in the pamphlet, the pages on the construction and design of bridges contain matter not always to be found in standard bridge treatises. For instance, there are outlined the steps in bridge construction, beginning with a selection of the site, the survey, the plans and specifications, letting the contracts, supervision, etc. There are many useful hints on methods of exploring for foundation and instructions as to features of general layout.

In the inspection of bridges a score sheet is given which indicates all the items that should be investigated in ordinary bridge inspection. The relative value of different types of small bridges, estimating curves for different types of bridges and the discussion of painting, all add to the value of the text. Finally, there is a summary of bridge legislation in other states than Oregon, which makes the book of value elsewhere.

Posthumous Edition of Stillman

ENGINEERING CHEMISTRY A Manual of Qualitative Chemical Analysis for the Use of Students, Chemists and Engineers. By Thomas B. Stillman, M. Sc., Ph D., Member, American Electro-Chemical Society Fifth edition Easton, Penn Chemical Publishing Co. Cloth, 6x9 in.; pp. viii + 760, 150 illustrations. $5.

The death of Dr. Stillman, in August, 1915, halted the completion of the fifth edition of his well known work on engineering chemistry. But the revision was well under way, and his sons have now completed the project. The work on the whole has been very well executed, so that the volume is reasonably up to date and can hardly fail to hold its place as an authoritative manual for the physical and chemical examination of the more used materials of engineering.

The new edition shows drastic rearrangement. The new sequence of topics is more logical, perhaps, though that is quite secondary in a book largely used for specific reference. The thoroughness of the revision is obvious: one can turn to hardly any section and not immediately see the changes. Chief among the longer discussions remaining little altered are those on water and paper examinations. Many of the shorter items, of course, are held intact.

There are extensive additions on the following topics, among others: Determination of sulphur in coal, sampling and analysis of fuels, calorific determinations, specifications for coke, sampling of iron ores, specifications for alloys, examination of portland cement, field testing of concrete, laboratory examination of road-making stones, flue-gas analysis, analysis of combustible gases, pyrometry, analysis of white pigments, turpentine and shellac.

The general method of procedure has been to discard those parts of the older edition which time has shown to be of lesser service. This condensation allows room for the inclusion of recent developments in examination methods, etc. About the best example of this sort of revision is seen in the handling of the old section on asphalt, to allow a large addition of material on bituminous road-making products, wood paving blocks, creosote oils, etc. A similar condensation is marked in dealing with the examination of lubricating oils, where space has been provided to let in new notes on testing of the most modern products, like internal-combustion-motor oils, greases, fuel oils, linseed oil, etc.

Steam Engineering Simplified

STEAM POWER—By C. F. Hirshfeld, M. M. E., Professor of Power Engineering, and T. C. Ulbricht, M. E., M. M. E., Assoc. M. Am. Soc. M. E., formerly Instructor, Department of Power Engineering, Sibley College, Cornell University. New York: John Wiley & Sons. [Wiley Technical Series.] Cloth; 5x8 in.; pp. viii + 420; 232 illustrations. $2 net.

The great majority of attempts to popularize steam-engineering texts is marked by the neglect of thermodynamics and deeper theory. The authors of this little book have jumped out of the rut and boldly attempted to lay bare some of the physical concepts of the inner details of steam-power practice. The extent of their success will surprise many mechanical engineers who have held that heavy reliance on mathematics is essential.

The authors, going no farther than algebraic processes for their tools, have enabled non-mechanical engineers and practical mechanics of limited education to penetrate as far as temperature-entropy relations, the Rankine cycle, etc., and to approach the theory of steam-turbine design. They have showed so much ability in the execution of this task that many teachers will regret that they did not have the hardihood to go one step farther and try to visualize entropy itself—for entropy, the abstract, still remains the big rock of discouragement in popular thermodynamic discussions.

The book opens with a short review of elementary physics—briefly discussing matter, energy, work, heat, temperature and power. It describes the properties of steam and the action of the ideal reciprocating engine, leading up to the complete- and partial-expansion theoretical working cycles. Entropy diagrams are explained (entropy, however, remaining an abstract intangible "property") and their practical employment described. The practicalities of the real steam engine are contrasted with the expectations from the ideal; effects of condensation, compression, clearance, etc., are noted, and actual types of mechanical-engine structures are pictured. The indicator diagram and its value have an important place, and this is followed by sections on compounding, slide-valve gears, on Corliss, poppet-valve and "una-flow" designs, etc. After steam turbines, condensers are taken up. Fuel-combustion processes, properties of fuels, details of leading types of furnaces and boilers complete the work.

Taylor and Thompson Revised

A TREATISE ON CONCRETE, PLAIN AND REINFORCED: Materials, Construction and Design of Concrete and Reinforced Concrete, with chapters by R. Feret, William B. Fuller, Frank P. McKibben and Spencer B. Newberry—By Frederick W. Taylor and Sanford E. Thompson, M. Am. Soc. C. E., Consulting Engineer. New York: John Wiley & Sons, Inc. Third edition. Cloth; 6x9 in.; pp. xx + 885; 262 illustrations. $5 net.

The third edition of this standard work on concrete brings the discussion of the material down to the end of 1916. According to the preface, the entire volume has been revised and largely rewritten. The chapter on reinforced concrete has been divided into three chapters, giving respectively the theory, tests and the design. In the chapter on building construction, modern details and the methods of handling design in drafting rooms are added. A chapter on beam bridges has been written. The various revisions in practice brought about by the new specifications for cement and for concrete adopted in 1916 are incorporated in the book wherever such incorporation is necessary.

Taylor and Thompson's "Concrete" has a field all its own. It combines probably better than any other American book a discussion of material, design and construction. Being brought down to date, it is now doubly useful.

Minor City-Planning Competition

CITY RESIDENTIAL LAND DEVELOPMENT: Competitive Plans for Subdividing a Typical Quarter-Section of Land in the Outskirts of Chicago—Edited by Alfred B. Yeomans, Landscape Architect. Chicago, Ill.: University of Chicago Press. Cloth; 9x12 in.; pp. 138; illustrated. $3 net; postage extra; weight, 3 lb.

Belated though it is in publication, this report on a minor city-planning competition held in 1913 by the City Club, of Chicago, is a most interesting and instructive volume. Each of many plans entered in the competition is described and illustrated by the competitor. There is a brief report by the Jury of Award and a series of reviews of the plans, from various pens. The volume will

repay careful study by engineers, architects, landscape architects, landowners and real-estate men having to do with the laying out of city residential areas, particularly flat areas without water frontage. The editor and publisher have done their work well.

Some of the many ways an engineer can help in giving public streets a pleasing appearance are shown by text and views in a pamphlet entitled "A Civic Duty for Engineers," by S. E. Doane, chief engineer, National Lamp Works, General Electric Co., reprinted from the *Journal* of the Cleveland Engineering Society by the National Lamp Co., Cleveland, Ohio. The address given in the pamphlet was delivered in December, 1915, before a joint meeting of the society just named and the Cleveland section of the American Institute of Electrical Engineers. Some of the views show lamp poles and brackets, but other street furnishings are shown as well as various buildings.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ARKANSAS DEPARTMENT OF STATE LANDS, HIGHWAYS AND IMPROVEMENTS: Annual Report, 1915-16—Little Rock, Ark.: State Highway Commission. Paper; 6x9 in.; pp. 127; illustrated.

THE AMERICAN PETROLEUM INDUSTRY—By Raymond Foss Bacon, Director, and Allen Hamor, Assistant Director of the Mellon Institute of Industrial Research of the University of Pittsburgh. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.. Vol. I; pp. x + 446; 155 illustrations. Special chapters by F. G. Clapp, Roswell H. Johnson, J. P. Cappeau and L. G. Huntley. Vol. II; pp vi + 447-963; 173 illustrations. $10 a set.

ARITHMETIC FOR ENGINEERS: Including Simple Algebra, Mensuration, Logarithms, Graphs and the Slide Rule—By Charles B. Clapham, Lecturer in Engineering and Elementary Mathematics at the University of London, Goldsmiths' College. New York: E. P. Dutton & Co. Cloth; 6x9 in.; pp. xi + 436; 149 illustrations. $3 net.

CALCULUS—By Herman W. March, Ph.D., and Henry C. Wolff, Ph.D., Assistant Professors of Mathematics, University of Wisconsin. New York: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. xvi + 360; 125 illustrations. $2.

CONDENSED REPORT OF THE AMERICAN UNIFORM BOILER CODE CONGRESS, Washington, D. C., December, 1916, Held Under the Auspices of the Industrial Commission of Ohio—Erie, Penn.: The American Uniform Boiler Law Society. Paper; 8x11 in.; pp. 87.

ELEMENTARY CAMS—By Franklin DeRonde Furman, M. Am. Soc. M. E. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. vi + 90; 69 illustrations. $1.25.

ENGLISH AND ENGINEERING: A Volume of Essays for English Classes in Engineering Schools—Edited by Frank Aydelotte, Professor of English in the Massachusetts Institute of Technology. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xix + 390. $1.50 net.

HARD WATER AND HEALTH—By Frank Leslie Rector, B.S., M.D. New York: A. R. Elliott Publishing Co. Reprinted from the New York "Medical Journal." Paper; 5x8 in.; pp. 13.

The author concludes "that the weight of authoritative evidence is in favor of the use of a natural water containing a moderate amount of mineral, at least enough to avoid the flatness in taste of distilled and soft waters." A list of references is given.

THE INDUSTRIAL AND ARTISTIC TECHNOLOGY OF PAINT AND VARNISH—By Alvah Horton Sabin, M.S., M. Am. Soc. M. E. New York: John Wiley & Sons, Inc. Second edition, thoroughly revised. Cloth; 6x9 in.; pp. x + 473; illustrated. $3.50.

IOWA ENGINEERING SOCIETY—Proceedings for 1916. Iowa City, Iowa: The Society. Paper; 6x9 in.; pp. 164. 50c.

LABOR DISPUTES AND PUBLIC SERVICE CORPORATIONS: Proceedings of Academy of Political Science in the City of New York—New York: Columbia University. Vol. VII, No. 1 (January, 1917). Paper; 6x10 in.; pp. iv + 189. $1.50, paper; $2, cloth.

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"This specification," the circular states, "is the result of several years' work of a Joint Conference representing the United States Government, the American Society of Civil Engineers and the American Society for Testing Materials. It was adopted by the United States Government and by the American Society for Testing Materials, to become effective Jan. 1, 1917."

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Notes from Field and Office

Night work may be economical—Portable steel buildings easily erected—The army truck on the Mexican border—Cement mortar repairs to stonework—Jacketing wood piles

Night Work Frequently Is Economical

By J. L. Harrison*

The comments in regard to the efficiency of night work. in *Engineering News*, Aug. 17, 1916, and the notes by Hunter McDonald in the issue of Oct. 26, 1916, together with some observations of my own, lead me to think that the ramifications of this question have not been very fully thought out by the average contractor. Roughly speaking, contracting costs may be divided among (1) materials, (2) labor and its superintendence and (3) plant. Now it will not be seriously contended that items falling in the first classification are modified appreciably by working at night. Items in classification (2) may be, in fact usually are, modified unfavorably by night work as ordinarily carried on. Here the average contractor usually closes his analysis of the situation and asserts the increased cost of night work. However, if he would analyze the third classification—his plant cost—he would often find a gain that would more than offset any necessary labor loss.

Years ago the writer worked for a time in the East Pittsburgh plant of the Westinghouse Electric and Manufacturing Co. Even then this plant was enormous, but it lay absolutely idle during more than half of each working day. Had the plant been only half as large and worked two shifts instead of one, the labor cost would have been about the same, but the plant charges would have been cut about in two, to the great advantage of the company. A vivid idea of what this may mean in dollars and cents can be had by analyzing the annual report of any large industrial company.

It is pretty generally admitted that machinery and equipment usually become functionally obsolete before they are worn out. In other words, old machines are scrapped because new ones can be secured to do their work better and cheaper, rather than because the old ones are actually worn out. Depreciation is not, therefore, as accurately expressed as a function of the number of hours work done by a machine as it is as a function of human progress; and it is consequently possible to reason that, if one man gets two hours of work out of a machine where his neighbor gets only one, he has obtained a large advantage. The phenomenal success of the Ford factory is, in no small degree, based on this principle. Usually, people talk of the "low capitalization" of this unique plant. This low capitalization is of course a reality, but its interest for the contractor lies in the fact that there is probably no other plant in the world where the full capacity of the equipment used is so nearly reached as at the Ford plant.

Now to come back to the question of night work, it is both more easy to maintain a high labor efficiency in night factory work and to see the lower plant costs per unit of work done on two- or three-shift work, when factory conditions are considered than when ordinary contract work is examined. Yet the same general conditions prevail. In the first place, successful night work depends absolutely on adequate light. This is not so much dependent on the quantity of light as on its proper distribution. A few large lighting units may throw more light than a good many small units; but if they are so placed that they throw heavy shadows, the work done under them is almost sure to be inefficient.

In the next place, night work must be kept up so long that the laborers get used to it. This is very important. In fact, the impression that night work is expensive is largely due to the high costs that have been obtained during abortive experiments with it.

Another point of considerable importance is the fact that, for some reason, contractors usually put their best superintendents on the day shift and their second-rate men on the night shift. This has an adverse effect on efficiency in general and results in unfair conclusions as to labor costs.

When the excessive temperature of the daylight hours during the summer months is considered, it seems remarkable that more effort has not been made to develop the possibilities of night work. The writer can find no adequate reason for it, either in factory production or on contract work, unless it be the natural preference of all normal human beings for daylight work. However, plant and equipment are becoming a larger and larger percentage of the unit costs of the finished product, in both factory and field production, and unit costs can be reduced in no other way so easily as by making the rate of actual useful wear on the plant at least keep up with the rate of functional depreciation. At present this can be done only by working two or more shifts.

Not so long ago railroads of America ran only during the daylight hours. But where is the railroad in America today that could stop running at night and pay dividends? The increased capital cost that would be required to handle the present railroad business between sunrise and sunset would be tremendous. In the Philippine Islands an English concern has been running a railroad on the daylight plan. Its president told the writer not long ago that he guessed the road would have to be double-tracked before it could pay dividends! We smile over such antediluvian ideas—yet many of our American factories and most of our contractors are planning to double-track their plants rather than *double-shift* their present equipment. The railroads have stood up nicely under the "lower labor efficiency" of night work, and so has the Ford plant. And so could every contractor who has more work than equipment, if he would give the matter his careful attention.

*Civil Engineer, Bureau of Public Works, Iloilo, P. I.

Erecting a Portable Steel Building

Buildings of sectional construction, as shown in the accompanying view, are being used for structures of various sizes and purposes. The steel frames support the roof trusses, and between them are fitted side sections or panels 8 ft. long and 8 to 18 ft. high. The panels may be solid or filled with windows. The ends, doors and other parts are made in the same way. The framing is of heavy steel angles, and corrugated painted sheets are used for the sides and roof. Kneebraces connect the trusses and side posts, and horizontal braces stiffen the corners. Diagonal bracing is fitted in some of the side panels. For foundries, etc., a monitor roof is added to provide ventilation. The parts are put together with bolts and clips, the only tools required being hammers, drift pins and wrenches.

SECTIONAL STEEL BUILDING

This construction is being employed for both temporary (or portable) and permanent buildings for railway and manufacturing purposes, such as section and toolhouses, machine shops and car-repair shops, and especially for pumphouses, power houses, etc., in the oil fields and oil refineries. The view shows a shop building 24 ft. wide, with the trusses braced between the side posts. These sectional buildings are manufactured by the Steel Fabricating Co., of Chicago, Ill.

Lessons from the Army Motor Trucks on the Mexican Border

By C. F. Harrington*

The very extensive use of motor trucks by the United States Army on the Mexican border in 1916 gives several lessons in the adaptation of power vehicles to military transportation service under trying conditions. The writer had a chance to watch the trucks and reports a couple of these lessons here—(1) on getting past bad spots in the roads, and (2) on the strain upon drivers. The trucks are driven and cared for mostly by civilian drivers, but there are a few enlisted men in this service.

Truck companies have been organized consisting of about 60 trucks each, with one driver to a truck, and they are stationed at different bases. The function of these truck companies is to carry supplies to the outlying bodies of men, and in some cases to carry the men themselves. The system under which these trucks are handled is very complete, and in Mexico they make their trips with almost railroad regularity. The men make two or three trips into Mexico, take a day to go over their engine, and then they have a day or two to themselves.

*20 Circuit St., Boston, Mass.

The trucks used are of different makes and include rear-wheel chain-drive and four-wheel-drive equipment. This last-named type of truck is powerful and can carry a very heavy load over rough country, but without any load it seems too light for towing. This may be shown by citing one instance. There was about a mile of road under construction at one point between El Paso, Tex., and Las Cruces, N. M., and here the trucks were compelled to turn off into the sand. They had to plow through soft sand and adobe dirt sometimes hub deep; in wet weather they had slippery places and heavy adobe mud to contend with. A good many of the trucks were stuck here every time they passed through, and other trucks were called upon to pull them out. To my observation the rear-wheel-drive trucks proved more successful in such emergencies. The four-wheel-drive truck seemed too light to utilize the power it had. It would appear that each company might well have a heavy tractor to tow the trucks past bad spots—saving time and wear on equipment.

The road maintenance is a big problem on the Mexican border. The soil, of course, is very soft and sandy, and the army engineers have made only temporary roads. With over 200 heavy trucks passing daily the roads are quickly worn out.

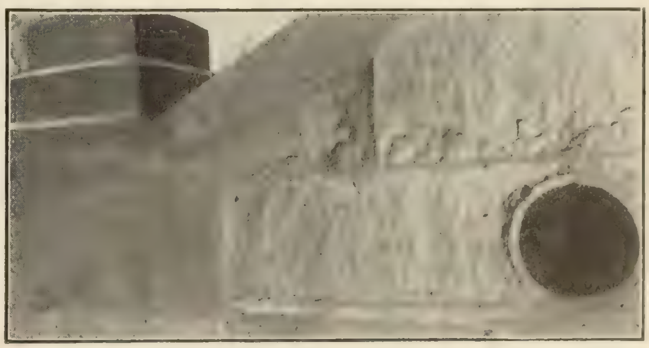
While the wear and tear on the trucks can be cared for at the service stations, a worse trouble is the effect of the hard riding on the men. Drivers are continually being treated for internal injuries. In one instance an army officer who had gone into Mexico in his own car (which broke down) had to ride back on a truck to Columbus. He was about 35 years old and in good physical condition. But when he reached Columbus, he had to be taken to the hospital. The comfort of the men should be looked after more in the designing of the truck than it now is. The important things in the eyes of the designer are power and capacity, and the comfort of the driver is too little thought of.

Cement-Mortar Repairs to Stonework

By J. S. Lindsay*

The Sedgwick County courthouse in Wichita, Kan., erected about 30 years ago, has shown rapid deterioration during the past two or three years. It was built of Sawley County (Kan.) stone, which is quite soft. Last

*County Engineer's Office, Wichita, Kan.



STONEWORK PARTIALLY FACED WITH CEMENT MORTAR

summer W. F. McCabe, a local contractor, faced and repaired with cement mortar all the steps and other worn parts of the ground floor of the building, and plans are being made for surfacing the entire building next year.

The contractor selected high-grade lumber for forms. The work done last summer was not far enough above the ground to render it impossible to brace the forms from the ground or from projections on the building. Forms, built of finished 2-in. lumber, were made up complete by the planing mill. No form marks were allowed to show.

In preparing the stonework the first operation was to clean it with a wire brush. Afterward it was thoroughly soaked by a stream of water from a hose. It was then given a neat cement wash, put on with a brush. The forms were next erected, and a 1-in. layer of 1 : 3 cement-sand mortar was applied quite wet, by means of a brush. Neat cement finish was given to all the work in similar manner. The top of the steps was tamped and troweled.

The mortar, which was laid on only when the work was shaded as much as possible, was immediately covered and was kept damp and cool; forms were removed after 24 hr. No difficulty was experienced in getting a bond between stone and concrete.

Sand was available costing 70c. per yd. on the work. Cement cost 40c. (at the rate of 42½c. per sack) on the work. Two men were employed, one receiving $3 per day; his helper was paid $1.75. These two placed 8 sq.yd. per day. Exclusive of form costs, it is calculated that the work was done for about 80 to 90c. per sq.yd. The cost will be considerably increased as soon as the work is carried farther above the ground.

Ohio County Paving Job Presents Some Unusual Construction Features

The asphalt paving of Euclid Ave. through East Cleveland, Ohio, during the season of 1916, involved some unusual construction features. The work was in two parts and was done by two contractors employing different types of the same asphalt plant. The length of the work was 2.64 mi.

The street is 86 ft. wide between building lines and 54 ft. between curbs, with a central strip of 19 ft. occupied

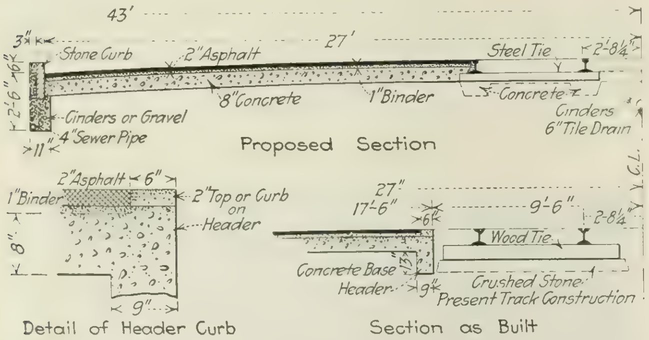


FIG. 1. METHOD OF PAVING OUTSIDE THE CAR TRACKS, EAST CLEVELAND

by the street-railway tracks. The refusal of the street-railway company to relay its tracks to conform to the new grade of the street made special construction necessary.

The paving consists of an 8-in. concrete base, a 1-in. asphaltic close binder course and a 2-in. top course of sheet asphalt with portland-cement filler. The concrete is a 1 : 2½ : 5 mix, with coarse aggregate of ¼ in. to 2½ in. The curbs are of Berea stone, 5x20 in., set on a bed of cinders or gravel in which a 4-in. tile drain is laid.

Instead of extending the concrete base to the tracks, as in the original design, it was extended only 17½ ft. from each curb (or to within about 2 ft. of the nearest rail) and ended in a 9-in. header or supporting wall 13 in. deep below the subgrade. On the edge of this was built

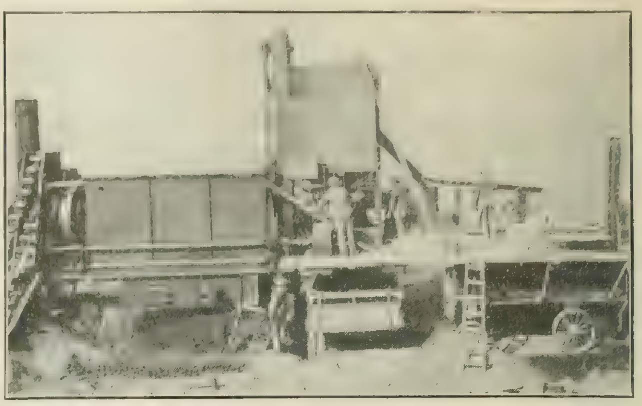


FIG. 2. PORTABLE ASPHALT PLANT WITH MOTOR TRUCKS FOR DISTRIBUTING THE MATERIAL

a concrete curb 6 in. wide and 3 in. high, its top being flush with the surface of the asphalt. The top finish of this curb, to a depth of 2 in., was made with a 1 : 1 : 2 mix, in which crushed granite was used as the coarse aggregate. It is anticipated that this part of the curb will be cut off flush with the base when the pavement is extended to the car tracks.

The track space between these headers is paved temporarily with brick, having a mastic filler. On each side this brick paving is sloped from the uniform grade of the header curb to the varying level of the heads of the outer rails, which is as much as 8 in. above and below the street grade. This makes an unsightly appearance.

On account of the narrow width of the paved driveway, 17½ ft., and the impossibility of working across the full width of the street, neither of the contractors was able to roll the surface transversely. The necessity of interrupting the work at cross-streets, in order to maintain some of the latter open for traffic, also hindered systematic progress.

The western half of the work, 1.29 mi., was done by the Cleveland Trinidad Paving Co. This company used Bermudez Lake asphalt and prepared it in a Cummer stationary plant equipped with a drier heated by oil fuel. The material was distributed on the street by motor trucks, the haul being from 5 to 7 mi. The company's asphalt-surfacing force was composed as follows: One foreman, two roller men, four rakers, two tampers, one smoother, two dumpers, six shovelers and two laborers. On account of traffic conditions it was impracticable to complete the surfacing at one move, but this gang had to move to different parts of the work at five different times, which added to the expense. Nevertheless, with 8-hr. shifts this company averaged 3600 sq.yd. of 1-in. close binder and 1800 sq.yd. of 2-in. surface per day.

The eastern half of the work was done by Pace Brothers, of Cleveland, who used Aztec asphalt. Their material, which was prepared in a Cummer portable plant of 1800 yd. capacity, installed about a mile from the

center of the work, was distributed by motor trucks. With this plant the average output per 8-hr. day was 3000 sq.yd. of binder and 1500 sq.yd. of top surfacing, while the maximum outputs were 3550 and 1750 sq.yd. respectively. This plant had a new type of sand drier that proved successful in handling fine and wet sand. Fig. 2 is a view of the plant.

Each contractor used a Foote mixer for the concrete, and each had two rollers for finishing the asphalt surface. The concrete mixer employed by Pace Brothers was equipped with a Jones distributor, which is said to have greatly improved the character of the work, while at the same time it reduced the labor of shaping the foundation.

The work was done under the direction of D. Moomaw, County Road Engineer, Cleveland, Ohio.

Special Forms for Jacketing Wood Piles with Concrete

A system of wood-pile protection from marine borers by the use of concrete casing has been devised by A. Neubert, a master diver of Oakland, Calif. The system of unit concrete forms for incasing piles above and below water, upon which the method of protection depends, has been patented by Mr. Neubert.

These forms are made in units of stock-size lumber. Standard machine bolts are used for attaching the crosspieces to the side members, as shown in Fig. 1, and 80d. nails bent over at the top serve to connect the units together as pins through the crosspieces. The edges of the side-form units are beveled and are drawn together by twisting the pins, which work eccentrically in the holes in the crosspieces. These crosspieces or hoops are placed every vertical foot. The completed forms are hexagonal or octagonal in cross-section and can be erected at any angle in order to inclose batter piles.

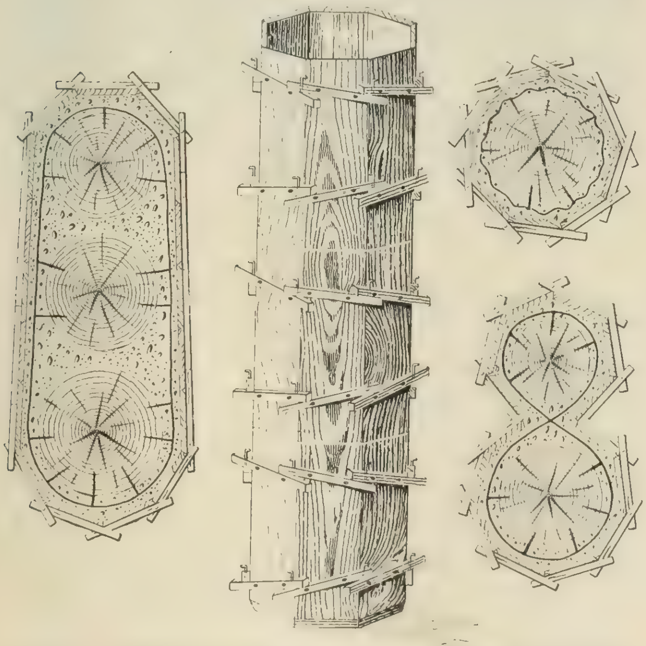


FIG. 1. NEUBERT SYSTEM OF ENCASING WOOD PILES IN CONCRETE SHELLS

The equipment for a single concreting gang consists of 120 lin.ft. of forms, which is enough to allow the concrete to set for 24 hr. Three flatboats capable of carrying 1½ cu.yd. each of concrete aggregate, a scow for water, with a deck for use as a concrete-mixing platform, two rafts for carrying the forms, and one small flat-bottomed rowboat complete the equipment. The working force consists of a foreman, two men to place concrete and erect the forms, and four men to mix and pour the concrete. This outfit, it is claimed, will place on an average of 40 lin.ft. of concrete-pile casing per day. The work can be organized into any number of gangs of this size.

The accompanying illustration, Fig. 2, shows the pile-trestle approach of the Coos Bay bridge of the Willamette Pacific R.R., protected by the Neubert system. The underwater sections were placed by a diver. These forms gave an octagonal shell of concrete 8 in. thick around each pile. A reinforcement of wire mesh was also used, placed near the outside of the shell of concrete. This wire netting was held in place by nails and spikes driven into the piles. The pile casings of the three or four bents nearest the bridge average 37 ft. in length. Cross-braces and diagonal braces up to 6 ft. above tide level were included in the concrete casing, using the same system of forms.

FIG. 2. WILLAMETTE PACIFIC R.R. BRIDGE OVER COOS BAY, OREGON

Comparison of Horse and Motor-Truck Hauling in Pennsylvania

By G. F. Alderson*

There has been an excellent chance during a year past to compare team and motor-truck haulage of road materials in the service of Longwood, Inc., of Kennett Square, Penn., a concern operating a 500-acre estate in Chester County. The cost per ton-mile has been 23.8c. for teams and 16.5c. for trucks.

In addition to the construction work about a large estate, the corporation repairs and maintains 10 mi. of macadam roads and from time to time constructs new sections. William M. Francis, of Wilmington, Del., is superintendent, and the writer, acting in a subordinate capacity, comes in direct contact with the details of the work. The subject matter herein is the result of his own personal observation and collection of data.

Considerable quantities of crushed stone and screenings have to be handled in the course of a year, so that

*Kennett Square, Penn.

economical haulage is important. A $2\frac{1}{4}$-ton standard chassis (Autocar) was bought and fitted with a special body with a power dump and driver's cab. The outfit cost $2100. Both truck and teams have been used in hauling the same materials.

Daily record sheets give an exact account of the truck's operations. Each day the driver turns in a sheet properly filled out. A hubmeter records the daily mileage. A typical sheet shows the following items:

Date	Nov. 17, 1916
Miles traveled	77
Number loads hauled	11
Material hauled	Crushed stone
Gasoline used, gal	$10\frac{1}{2}$
Cylinder oil used, pints	5
Distribution of time	5 hr., job 54-d; 5 hr., job 18-E-J
Remarks	11 loads of stone hauled from bins at Mendenhall
Driver	Bevan

The truck ran 12,000 mi. the first year. During that time the repair bill was very small; there were only minor breakdowns, making this item $20. For depreciation, 25% of the first cost was allowed; this, of course, was only an estimate that, at the end of the year, seemed to be ample. The fixed charges and cost of repairs on the truck for the entire year were as follows:

Depreciation	$525 00
Interest, at 4%	84 00
Repairs	20 00
Insurance	25 00
Total	$654 00
Total per mile	0 055

The following data were obtained from an average of the record sheets for the whole year:

Average daily mileage	66 20
Average daily consumption of gasoline, gal	10 75
Average miles per gallon of gasoline	6 16
Average daily consumption of oil, gal	0 66
Average miles per gallon of oil	102 00
Average length of haul, miles	2 85
Average number of loads per day	8 62
Average number of tons per day	19 40
Average number of ton-miles per day	55 30
Cost of Operating Truck One Day:	
Repairs and fixed charges ($0.055 × 66.2)	$3 64
Driver	3 00
Gasoline ($10\frac{3}{4}$ gal. at 20c.)	2 15
Oil ($\frac{2}{3}$ gal. at 45c.)	.30
Total	$9 09
Cost per ton-mile	0.165

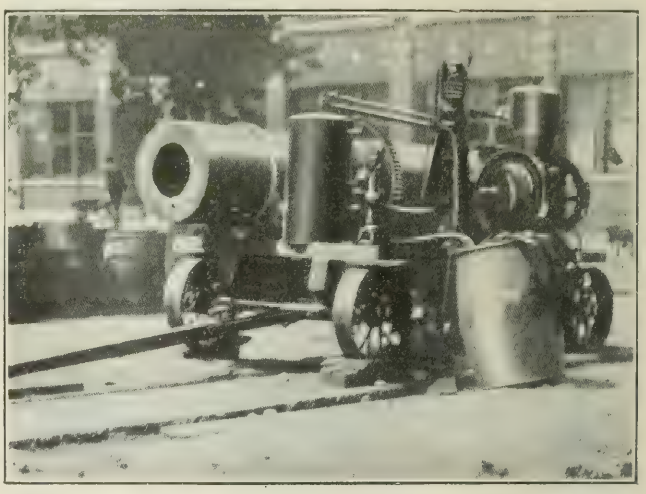
The teams that were used for hauling similar material were hired at $5 per 10-hr. day. This amount included the driver's wages. The teams were closely observed, and it was determined that the best results were obtained when a load of about 3500 lb. was hauled. A team doing a good day's work hauls four such loads a distance of 3 mi. in 10 hr., or the team is credited with 21 ton-miles per day. Hence, at 50c. per hr., the cost per ton-mile to haul the same material by teams amounts to 23.8c.

As is evident from the foregoing figures, it is 73c. cheaper per ton-mile to haul with the truck than it is to haul with teams. Last year the truck hauled a little over 13,500 ton-miles; or the total saved by the use of the truck was $985.50, which is almost half the cost of a new truck.

The low cost of operation of the truck per ton-mile and its decided economy over team hire for this kind of work seem to be due in large part to the fact that it is exactly suited to its work. On the long hauls, because of its speed, it outdistances the teams. Its greatest radius of operation per 10-hr. day is 33 mi., whereas the team can never get more than 12 mi. from home. The automatic dumping and quick return to the storage bins or cars make the truck especially desirable for the shorter hauls.

FINE AGGREGATE

The Cost of Tar Filler for a brick pavement on Ionia Ave., Grand Rapids, Mich., is given in the accompanying table. The tar used was the Barrett Manufacturing Co.'s special coal-tar paving pitch, having a specific gravity of 1.29 and a melting point of 120° F. This was heated in kettles to about 275°. It was mixed with sand (60% of which passed a 30-mesh screen) that had been heated by means of a Rapid Mixer Co.'s special sand-drying machine to a temperature of about 350° F. One bucketful of hot tar and one bucketful of hot sand were placed in an ordinary wheelbarrow and thoroughly mixed by means of hoes. The mixture was poured from the wheelbarrows on the brick pavement and was quickly worked into the joints by the use of squeegees. The joints were filled to the top, and a thin coat was left on the surface of the brick. The surface was then covered with a very light coat of torpedo sand and the street opened for traffic. The pavement was laid by the Carpenter Construction Co., of Grand Rapids, Mich. The bid for Metropolitan paving brick, including $1\frac{1}{2}$-in. sand cushion and tar filler, was $1.40 per sq.yd. Mr. Carpenter furnished the following figures relative to the cost of the filler:



SPECIAL SAND-DRYING MACHINE USED TO HEAT SAND TO 350° BEFORE MIXING WITH PITCH

Cost of paving pitch	$345.35
Cost of unloading pitch	17 00
Cost of sand (20 loads at $1.50)	30.00
Cost of kerosene (for sand-drying machine)	40.00
Rent for sand-drying machine	50 00
Cost of labor	335 00
Cost of wood and coal	9.00
Total cost	$826.35
Total square yards of pavement	$5,003.00
Average cost per square yard	0 165

The average cost per square yard could be reduced to about 15c. with sufficient kettle capacity. The men on this particular job spent considerable time waiting for the tar to heat.

A Cheap Machine for Cutting "Warrenite" Pavement was recently described by M. E. Starks, of Bridgeport, Conn., Track Superintendent of the Connecticut Co., before a meeting of the local company section of the American Electric Railway Association, as reported in the January issue of "Aëra," the association organ. The machine was devised by Mr. Starks and W. F. McCoy, master mechanic, and cost about $125. It consisted of a 20-in. cutter wheel carried in a heavy iron frame hinged to the side of a single-truck trail car and accommodating itself to inequalities of the paving to be cut. The device could be attached or detached in 10 min. The frame was loaded by running a truck, carrying 2 tons of old axles, off the trailer and upon the cutter frame. The company had 16,000 ft. of "Warrenite" paving to be cut back 2 ft. from the rails so as to allow repair of the track. It was only necessary to run the cutter up and down the street a few times. A crane car with one motorman and three or four laborers would cut a 3000- or 4000-ft. strip in one night after the last car had passed. This was more than 25 men could do in 10 hr. with picks and chisels, and a better job resulted.

Editorials

Good Writing and Good Engineering

Well-put English occurs in engineering reports oftener than some people think. It is a pleasure to put on record a pleasing example of this, which at the same time drives home a lesson in good engineering that needs to be learned by citizens, taxpayers, officials and perhaps some members of the engineering profession in every city having waterways subject to encroachment by the uncontrolled results of urban growth. We quote from the transmittal letter of W. W. Horner, Engineer-in-charge of the Division of Design—Sewers and Paving, St. Louis, Mo., accompanying a report on the River des Peres drainage problem, St. Louis, Mo., as follows:

Exactly forty years ago the City of St. Louis took to itself a portion of the River des Peres Valley. The stream was then a common country brook, clear and attractive, but subject to freshets which submerged an occasional cornfield. Since that time the city has proceeded to occupy the valley and has used the stream as a dumping ground for rubbish and sewage; and because the stream is no longer able to purify itself, it is loked upon with aversion.

The city has paved streets and covered the absorbent soil with roofs until the runoff of the freshet has greatly increased. It has filled up the banks of the stream and narrowed its bed and has placed valuable improvements and traffic ways in the old cornfields; and when the stream, attempting to carry off the increased burden under these handicaps placed upon it, floods more than before, the city is aghast and horrified.

The city has forced on the stream a utilitarian character, which it is unable to assume, and the result is an ugly and inefficient sewer. For over 15 years the people have been clamoring for the improvement of this condition, and during the most part of that time the city's engineers have been preparing for the day when the demand would become insistent.

Eleven years ago, the writer became connected with this study, and continually since then has had a part in the observations and planning. A general scheme was worked out several years ago and a certain part completed. As additional data were available, the plan has been modified and crystalized, but unofficially, and it is with great satisfaction that in response to your instructions the following report and plan is presented for formal consideration.

Such an introduction to a report creates interest and conviction at the start. It is a pleasure to note that the plan thus gracefully and forcefully submitted by Mr. Horner on Dec. 16, 1916, was soon approved by the Board of Public Service, of which E. R. Kinsey is President. The outstanding structural features of the plan were set forth in *Engineering News* of Feb. 1, 1917, p. 209.

New Emphasis on the Human Element in Engineering Work

A few weeks ago a largely attended conference was held at the Ohio State University to discuss the human element in engineering work. More recently a similar conference was held at Columbia University in New York City. Similar meetings have been conducted annually in Pennsylvania, for some years, under the direction of Dr. J. P. Jackson, head of the State Labor Bureau. These meetings at widely different points are significant of the fact that engineers and business men are taking a greater interest in the practical problems of sociology.

Most engineering students desire to fit themselves for executive positions. They understand that the large pecuniary rewards in engineering, as in all other lines of business, go to the man who has the ability to handle men rather than the man who deals solely with things. There has been a really amazing awakening among employers of labor everywhere to the necessity of dealing with labor with a degree of intelligence, tact and humanity that would have been condemned as soft-hearted foolishness a generation ago.

A criticism often made of the courses of study in the technical schools is that they give a man little or no instruction in the art of dealing with men. We have before referred to the remarkable movement in charge of the International Committee of the Young Men's Christian Association, which has been for the past few years developing in many engineering schools a plan of work whereby students in their junior and senior years may gain practical experience in dealing with the workmen with whom, later in their career, they may come in daily contact as managers.

This "Industrial Service" movement, as it has been called, has recently developed a college course for the study of the human side of engineering, covering 64 to 96 class periods, or four to eight months' work, with two or three recitations per week. The course includes such subjects as the evolution of the individual worker in industry, industrial organizations, relations of capital and labor, working conditions, living conditions, leisure conditions, ethics of engineering and business, vocational guidance, how to handle men, engineers' responsibility for service.

A course of study following these general lines seems well calculated to meet the demand that the engineering college should send out its graduates equipped with some knowledge of the foundation principles of dealing with men. Those desiring to obtain further information regarding this new college course can obtain it from the Secretary of the Industrial Service Movement, Fred H. Rindge, Jr., 124 East 38th St., New York City.

Crippling Their Own Water-Works

Making every tub stand on its own bottom is a good rule to apply in municipa' as well as other realms of human activity. There has always been a strong temptation to do otherwise in the municipal field in order to favor some weak service or to lessen the burdens of direct taxation at the expense of the patrons of some revenue-producing municipal enterprise. Water-works most often suffer by such spineless and unjust practices.

A case in point, where not one water-works but many throughout a whole state are involved, is afforded by Massachusetts. Here, according to the 1916 report of the engineering division of the Massachusetts State Board of Health, recently sent to the legislature, it is becoming common practice for municipal authorities to

use water-works surplus funds to meet the general expenses of the city. This would be bad enough if the needs of the water-works were amply provided for before drafts were made on the water-works revenues, but it is doubly or trebly bad when the income diverted to other municipal purposes is sorely needed to keep the works up to standards of quality, quantity and pressure.

Municipal authorities in Massachusetts and most if not all other states would do well to consider the fact that it is unfair to make a water consumer pay a part of the general expenses of the city when he settles for the water supplied him. The water charge should cover, and cover adequately, the cost of that service alone. Whether it does or not, few cities know, because water rates in the past have generally been fixed by guess or by blindly copying those of some other city. This is not all. Comparatively few cities really know whether their water-works are making or losing money. Unless the engineering division of the Massachusetts State Board of Health has closely looked into the matter, we should not be surprised if many of the cities that on the face of it are using water-works profits to reduce taxes are really only chasing the devil around the stump—the profits being apparent only. This, however, does not lessen the seriousness of the charge that the water-works are being crippled—so far as intent or carelessness is concerned—but it is an indication of municipal muddle.

Opportunities for Engineering Work in Foreign Fields

Those who have the largest outlook on the currents of trade industry and finance are united in the belief that unprecedented opportunities are open for the United States to undertake enterprises in foreign countries. The National City Bank, of New York, in its January *Bulletin* says:

> The opportunity to extend American trade abroad should be much better in the years following the war than during the war. We are able now to enter this field in a new capacity, that of an investor and organizer.
>
> The United States has become much the richest country in the world. Even before the war its annual gains available for investment were as great as those of any three other countries, and our preëminence in that respect is now greater. Our steel-making capacity is equal to that of all the rest of the world, and the same is true of our tool-making and machine-building capacity.
>
> There has never been a time when there was such pressing need for improved appliances for increasing production as there will be after the war. We can go out to the undeveloped countries and put into the hands of their people the means of opening new stores of wealth not only for themselves, but for the common supply.
>
> We have come into a position of leadership, but are we going to make ourselves felt in the organization and advancement of the world? If we really set about doing this and have anything like a national appreciation of what we can do, we need have no uneasiness about business opportunities after the war. There is no limit to the opportunities in Latin America, China, Russia and elsewhere. We are passing through times when ability, competency, readiness and willingness to render service beyond our borders count as never before and will be compensated as never before.

In this connection notice the curves of average yearly compensation of engineers, based on geographical groupings, compiled by the American Society of Civil Engineers Committee and published on page 41 of our issue of Jan. 4. That diagram showed that the average compensation of engineers engaged in work in foreign countries is far higher than the average compensation of engineers employed in any part of the United States. To a certain extent this rate of compensation for the engineer sent abroad must be discounted on account of the additional cost of living, the traveling expenses, etc., which the American engineer working in foreign countries necessarily has to incur.

In considering the opportunities for engineers abroad, however, it should be clearly understood that there, as well as here, the chief profits will go to the men who have the energy and the ability to undertake successfully the work of promotion and organization; and the engineer who merely performs on a salary the technical work of design and construction will be hired at as low a figure as his services will command in the market. The large prizes will go to the men who can perform the difficult work of finding the promising opportunities, judging which are actually valuable and which only appear so, and then bringing together the necessary capital and technical skill to make the opportunity yield profits. If the engineer combines with his technical knowledge the ability to act as a promoter and organizer, he has at least as good a chance for these prizes as anyone.

Increasing Cost of Producing a Graduate Mining Engineer

At a recent meeting of the Mining and Metallurgical Society of America the general subject for discussion was the great increase in the cost of mining and smelting ore which has taken place during the last three years, and Professor Peele, of Columbia University, referred to the heavy increase in the cost of engineering education. The average expenditure by the School of Mines of Columbia University on the average graduate in mining engineering, which was formerly \$2600 to \$2700, is now \$5000 to \$5500. One cause of this change is the substitution for the old four-year course of a three-year course, preceded by three years of scientific college training, or six years in all. An effect of this increased length of course is to reduce the number in each class, which means a proportionate increase in the cost per student.

These figures, it should be noticed, represent the gross cost to the university. Part of this cost is paid by the student himself in tuition fees, but only a small part, as the rate of tuition is only \$250 per year. The total cost to the student for his education is a much larger sum even than this, for besides his living expenses during the period of his education, the value of his time must be included, or, in other words, the amount that he would earn in some other occupation if he were not engaged in study.

It may be assumed that the average engineering student in the School of Mines could, during the six-year period of his professional studies, earn an average of \$800 a year. Add this \$4800 to the \$5500 estimated above as the total cost to the university, and it appears that a graduate in mining engineering represents a total investment, during his professional education alone, of over \$12,000. In fact, the sum is considerably in excess of this, for to be strictly accurate, interest should be figured on each year's expenditures.

In these days when so much emphasis is laid on accurate cost accounting and so much is said concerning the low compensation of engineering service, it is worth while to consider what a large investment is required to produce a finished engineer graduate.

Cleveland Engineering Society Urges Commission for City Paving

The City of Cleveland is to spend nearly $10,000,000 for the improvement of its pavements. The voters have indorsed a bond issue of $3,000,000 to provide money for the city's share of the work, and it is estimated that over two-thirds of the cost will be met by assessments on private property owners. The Cleveland Engineering Society recently adopted a resolution urging the city government to place this paving work in charge of a special commission. The members of the Engineering Society in making this recommendation were doubtless familiar with the experience at Baltimore, where a similar large outlay on street paving has been in progress for some years. The Baltimore work has been directed by a commission with a capable engineer at its head, and first-class work has been secured and is shown by the newer pavements. The Cleveland city officials, however, look with no favor on this proposal by the Engineering Society. Mayor Davis is quoted as saying that the city administration is responsible for spending this money and "does not care to be relieved of its responsibility."

The citizens of Cleveland may well ask their mayor why he is so anxious to retain this responsibility. Manifestly, he cannot discharge it personally and must delegate it either to the officials of the street department, now organized only to care for maintenance work, or to a special commission, as urged by the Cleveland Engineering Society. The experience of many cities has demonstrated that the latter plan is far more likely to produce honest and economical work. There ought to be an outspoken expression of public opinion in Cleveland to back up the Cleveland Engineering Society's proposal.

Letters to the Editor

Mill Construction a Well-Defined Type

Sir—I have read with interest the articles on "The Cost of Factory Buildings, of Timber and of Concrete," by F. E. Davidson and T. L. Condron, which appeared in the issue of "Engineering News" for Nov. 9, 1916. In the Dec. 21 number of your magazine you also printed a letter from Lewis Muhlhauser, which I interpret as intended to follow up the discussion between Mr. Davidson and Mr. Condron. This impression is drawn from the heading of the article and the reference made in the first line of the first paragraph.

I believe that the wording of the title for this article was unfortunate, since the text does not in any sense bear out the title. In fact, "mill construction" seems to play no part in the building described by Mr. Muhlhauser. It states very clearly in both the first and second paragraphs that the building in question in Mr. Muhlhauser's comparison consists of steel skeleton frame with wood-joist floors. In true mill construction heavy timber is used for the interior framing and floors. The type of construction in which steel beams and steel or cast-iron columns are used in place of heavy timber members is not true mill construction and should be given a different classification.

I feel that the heading used is very likely to confuse the public at large as to the true meaning of the terms applied to the various types of construction used in our modern factory or commercial buildings. While we will all admit that timber is not suitable for use in all locations, we must agree that heavy timber construction has its proper place and definite advantages, which have been proved by long experience, both of engineers and insurance companies.

C. E. PAUL.

11 South La Salle St., Chicago, Ill., Jan. 19, 1917.

Miami Flood-Frequency Studies Based on Many Lines of Study

Sir—R. W. Davenport's criticisms of the flood forecasting of the Miami Conservancy District, published in "Engineering News" of Feb. 8, p. 248, are, on the whole, well founded and show a keen appreciation of the complexities of the problem.

In the article to which he refers[1] it was impossible to dwell on all of the phases of the Morgan Engineering Co.'s studies relating to the frequency of occurrence of great floods. For that reason a large part of the data at hand could not be discussed by "Engineering News" and this, no doubt, is the cause of erroneous impressions reflected in Mr. Davenport's letter.

Briefly stated, the main conclusions as to storm and flood frequency were derived from a careful weighing of the evidence furnished by all of the studies taken as a whole, rather than from the logical development of any one line of investigation. Indeed, a very wide range of information was utilized, the most important part of which consisted of the longest available records of rainfall and of floods obtained in many different parts of the United States. Flood records extending over many centuries on European rivers were also consulted. Many secondary studies were made which served to throw light on various phases of the subject. Some of these were described in detail in the article in "Engineering News" referred to, because they contain novel methods and are therefore of special interest to the profession. Some of these should be looked upon, however, as being byproducts that were evolved in the course of the main investigation, of value chiefly in bringing out special features, and because they help to confirm the conclusions reached by the broader method.

Mr. Davenport criticises the method of adding the storm experience of one station to that of another for the purpose of computing storm frequency over long periods, holding that the results are not applicable to areas of the size of the Miami Valley. Since the method takes no account of area, he would be perfectly correct in stating that this study in itself furnished no proof that the results are applicable to anything more than one station. But other frequency studies made by the Morgan Engineering Co., not mentioned in the article referred to, do show clearly that the results of the method criticised can be applied to areas as large as the Miami Valley with fair accuracy. It is to be regretted that the scope of the article did not permit a discussion of these other studies. Arrangements are under way by which all of the studies are to be published in order that their results may be made available to the engineering profession. This will afford an opportunity of clearing up the point raised by Mr. Davenport in a more satisfactory manner than could be attempted within the brief scope of this letter.

As regards evidence of climatic changes within the past few centuries, the studies in this field made by the Morgan Engineering Co. show that within historic times meteorological conditions have varied in many ways, but that no definite change in one direction or another can be said to be noticeable. Examinations made of the longest rainfall records in the United States, and of flood records over long periods for rivers in different localities, fail to reveal any periodic or progressive changes indicative of a climatic change. The burden of proof still seems to rest with those who advocate such theories. This view is confirmed by a recent article by H. H. Hildebrandsson in the "Monthly Weather Review" of June, 1916, entitled "On the So-Called Change in European Climate During Historic Times," from which he concludes that though climatic variations of long and short duration exist everywhere on the globe, it is not possible to prove that the climate of Europe, within historic times, has changed in any respect. Prof. J. W. Gregory states as a result of his research that "in historic times there has been no worldwide change of climate."

[1]"The Miami Valley Flood Protection Works—Fixing Maximum Flood Limits," "Engineering News," Jan. 4, 1917.

Mr. Davenport suggests that it would be instructive to compare the frequency curves* published in the article under discussion with similar curves based exclusively on long-time records, as a means of showing whether or not any discernible climatic change has taken place during the period covered by the longest of our existing records. For instance, a set of frequency curves which was prepared from the 22 longest existing records in the Central States Basin, the average period of record being 41.6 years, is practically identical with those referred to, which were based on the records of 478 stations in the same area with average period of record of only 15.8 years. This, though not in itself conclusive evidence that the climate is not changing, does clearly prove that if such a change is taking place it is too slow to be indicated by existing rainfall records. Noticeable cyclic changes in rainfall appear to have been indicated in certain localities within a 20-year period, but these are at variance with each other for different parts of the eastern United States, a decrease in one locality being synchronous with an increase in another locality.

GERARD H. MATTHES,
Assistant Engineer, the Miami Conservancy District.
Dayton, Ohio.

*Fig. 9 on page 16 of "Engineering News" Jan. 4, 1917.

Chicago Paving Engineers Defended

Sir—The report on Chicago pavements, which was written, signed and printed in Urbana, Ill., by Prof. Ira O. Baker, of the University of Illinois, contains statements and opinions which have caused the people of Chicago to believe that the engineers of the Board of Local Improvements are corrupt, and that they have permitted paving contractors to rob the property owners of $400,000. If these statements and opinions are true, these engineers should be discharged in disgrace. If these statements and opinions are not true, Professor Baker has dishonored himself and should be denied the privilege of association with other engineers.

A portion of the alleged loss to property owners is said to be due to skimping on the percentage of bitumen in the asphalt top and binder. On page 22 of the report is a table showing the amount of bitumen in binder, and on page 28 is a table showing "actual" as compared to specified percentage of bitumen in wearing coat of asphalt pavements. It is a remarkable fact, which cannot be denied by Professor Baker, that these percentages are not based on chemical analyses, but are based upon computations made by one of the staff of investigators who had had no previous experience in asphalt paving, and who based his calculations on casual and incomplete information received from the asphalt inspectors at the asphalt plants. On pages 27 and 28 Professor Baker says:

5. Percentage of Bitumen—Data for the wearing coat like Table 1, page 22, for binder course, show that the bitumen in the wearing coat prepared by the different asphalt-paving contractors is as in Table 4, page 28. The significant thing in Table 4 is that all of the wearing coat prepared at one plant has less bitumen than the specified minimum; while all of the other plants prepare material for the wearing coat with only slightly more bitumen than the specified minimum. One would expect from the wording of the specifications that some of the plants might use asphalt, stone dust and sand of such a nature as to require more than the minimum percentage of bitumen, or that some one of them would lay asphalt on a street having travel that would require more than the minimum percentage of bitumen

TABLE 4. BITUMEN IN WEARING COAT OF ASPHALT PAVEMENTS

	— % Bitumen —	
Firm	Actual	Specified
Standard Paving Co.	9.2	11 to 13.5
White Paving Co (both plants)	11 4	11 to 13 5
Conway Paving Co.	11 6	11 to 13.5
American Paving Co	11 7	11 to 13 5

Table 4 shows the "actual" percentage of bitumen in the asphalt from the Standard Paving Co.'s plant was 9.2%. As a matter of fact, chemical analyses of samples of asphalt from this plant taken on the same day that the investigator was there show 11.5% of bitumen. This discrepancy was due to the fact that the investigator thought that the mixture contained Trinidad asphalt, while in fact straight Mexican asphalt was being used. Based upon this erroneous calculation, which was based upon one observation, Professor Baker assumes that "all of the wearing coat prepared at one plant has less bitumen than the specified minimum."

In all of these cases (on pages 28 and 22) the amount of asphaltic cement used in each batch was understated, no allowance being made for the "over-run," which is the amount of cement that flows into the weighing bucket after the scale tips and after the valve is closed in the pipe leading from the heating kettle.

In the table on page 22 the amount of bitumen in the binder from the White Paving Co.'s plant is given as 4.9%, and Professor Baker calls attention to this as being below the requirements of the specifications. This, if correctly computed, would be at least 5.3%. In regard to this he says:

According to the specifications the bitumen should be between 5 and 8%. The most important thing shown in Table 1 is that the percentage of bitumen is in all cases very low. In one case, it is below the minimum limit of the specifications; and in the three other cases the amount of bitumen is very near the minimum limit. The average is 5.4%.

The bitumen is by far the most expensive ingredient, and any decrease in its amount means an appreciable profit to the contractor. Since it required approximately 140 lb. of binder to cover 1 sq.yd. of street, a variation of 1% in the amount of bitumen would mean a variation of 1.4 lb. per sq.yd. On a day's work, say 2000 sq.yd., this would mean a saving of 1.4 cu.yd. of bitumen, or approximately 2 tons of refined asphalt, which according to present prices is worth approximately $40. Hence, by using 5% of bitumen instead of 6%, the contractor can save on binder alone approximately $40 on each day's work.

One not acquainted with the practice of laying asphalt pavements would infer from this that it was the duty of the contractor and the engineers of the Board of Local Improvements to see that at least 6% of bitumen was contained in the binder. The standard specifications of the American Society of Municipal Improvements provide for bitumen to range from 4 to 7%.

In the Chicago specifications our minimum amount, 5%, is what we consider good practice, and we usually get 5.5%. To put in more than 6% would make a soft binder that is undesirable. Professor Baker would be entitled to express a different opinion, if he did not use it to convey the idea that the paving contractors of Chicago were "saving" $40 a day on each job, and in order to do this he assumes that the "actual" amount of bitumen is even less than the computed amount.

C. D. HILL,
Engineer, Board of Local Improvements.
Chicago, Ill., Jan. 18, 1917.

The Public as an Employer

Sir—Your editorial of Dec. 21, 1916, entitled "Do Engineers Need To Eat?" raises an important question of wage theory, on which the Bureau of Municipal Research of Philadelphia would like to make its position clear

After quoting from a report of the Detroit Bureau of Governmental Research on Detroit sewer construction, in which the salaries of certain engineering positions of the lower grades are criticised as too high, your editorial takes issue with the author of this report and points out that when compared with employments requiring less training and experience these engineering positions are not too liberally compensated.

As the report of the Detroit Bureau of Governmental Research sets forth, it is doubtless possible to secure young engineering graduates for less money than the City of Detroit is paying, and from the standpoint of economical management it seems proper to take advantage of this condition. The question is, Should salaries and wages be dealt with solely from the standpoint of economical management? Our answer is, emphatically, No. It is our view that the prime consideration in fixing salaries and wages ought to be the welfare of the worker. All other considerations should be subordinated to this one.

Certainly, government is an instrument of social welfare. If this is true, ought it not to be one of the prime concerns of government to look after the welfare of its own employees? Are they not as much an object of the welfare activities of government as those who are not in the public service? Since a man's salary, or his wage, is one of the most vital factors that make for his well being, the government ought to see that above all other things its employees are given adequate compensation for their services.

This does not mean that a city or state should wholly disregard present financial limitations and all other obligations in order to pay what it believes to be ideal salaries and wages; it does mean, however, that the problem should be approached from the standpoint of what is for the welfare of employees rather than from that of economical management. If necessary, let us compromise, but let us not lose sight altogether of the more important object.

FREDERICK P. GRUENBERG, Director.
Philadelphia, Penn., Jan. 26, 1917.

An International Exposition to be held at Boston in 1920 to commemorate the three-hundredth anniversary of the landing of the Pilgrims is proposed by the Pilgrim Tercentenary Commission, of which Arthur Lord, of Boston, is Chairman. The commission recommends a site for the exposition at South Boston, 1½ mi. from the State House, comprising 500 to 600 acres. The expense of creating the exposition is estimated at $15,000,000, and an estimate of about $1,900,000 additional is made for permanent memorials at Plymouth

Concrete Institute Meets at Chicago

Papers of uncommon excellence, which brought forth surprisingly little discussion on the floor, were the distinctive features of this year's convention of the American Concrete Institute, held in Chicago, Feb. 8 to 10. This combination was somewhat disappointing, because the management of the society had made an unusual analysis of the program needs of a convention and had decided to eliminate certain types of papers which in previous meetings had proved dreary and dry. As a result the program, as announced, was most promising and a highly interesting discussion might have been anticipated. The papers themselves fulfilled the expectations but, as has been said, the discussions were below par, although at the same time the familiar emphasizer of the obvious was conspicuously absent. Then, too, a rigid adherence to a time schedule cut short some useful discussions which promised to unfold new experience. The attendance at the meetings, however, was greater than at any of the recent conventions.

The Institute is in a financially secure position. Through strict economy and good management it has brought its balance from the debit to the credit side of the ledger and may be expected now to increase in a healthy growth. The new President is Prof. W. K. Hatt, of Purdue University, and the Secretary is H. D. Hynds, 30 Broad St., New York City. All of the past *Proceedings* are now in print or about to be distributed and it is hoped that the *Proceedings* of the present convention will be available at a much earlier date than has been usual.

Concrete Regulations Under Discussion

The high point of the meeting was the discussion of the report of the Committee on Reinforced Concrete and Building Laws, which submitted for adoption "Standard Building Regulations for the Use of Reinforced Concrete." These regulations present in codified form the committee's long-considered opinions on the practical design and construction of reinforced concrete and are intended to be used as a guide not only to builders but to the framers of building codes. At any time in recent years such a report would have great importance as a step toward the desired uniformity in practice but just now its importance is emphasized by the recent issuance of the final report of the Joint Committee on Concrete and Reinforced Concrete. The Joint Committee's report is not a building code but it does contain the basis of a building code, the difference being only a matter of form. The Concrete Institute Committee report, on the other hand, is a building code, but in any consideration of the two reports the essential elements of design are of sufficient similarity in intent to invite a direct comparison of the two reports.

Such a comparison is necessarily too lengthy to be made here, but, in brief, it may be said that the two reports differ radically in many details of design, particularly in regard to hooped columns and to flat-slab floors, and that the Joint Committee report is by far the more conservative of the two. A typical comparison of provisions may be noted in Mr. Condron's tabulation of flat-slab coefficients noted on another page of this issue. Incidentally, for what it is worth, the information is offered that the prominent members of the Joint Committee are all of the engineer-designer class whereas the Concrete Institute's committee is enlisted from the concrete-building contracting field.

The Concrete Institute Committee report was passed to letter ballot for adoption, following a defence of the flat-slab provision by Arthur R. Lord of the committee and objections to the same provisions by Prof. A. N. Talbot, of the Joint Committee. After the passage to letter ballot, however, the attention of the meeting was directed to the fact that the Concrete Institute was represented on the Joint Committee by three members who, with some dissension on points not in controversy between the two reports, signed the Joint Committee report. In consequence the Institute is now in the anomalous position of appearing to subscribe to two reports which differ radically on most important details. After considerable parliamentary wrangle—during which the Joint Committee's report was formally "received" by the meeting and the explanation made that the several signatures of Institute members to that report neither committed the Institute to any part of the report nor the signers themselves to all of the report—the "Building Regulations" were withdrawn from the letter ballot of this year and passed over until next year. Meanwhile it is understood that the Joint Committee's report will be turned over to the Institute committee for consideration and explanation of the reasons for divergence from it.

Committee Work Outlined

Other committee work passed to letter ballot were the specifications for reinforced-concrete fence posts and the revised specifications for concrete roads, streets and alleys, which was amended in minor matters from the present standards. The Committee on Concrete Sewers presented a well-considered standard specification for monolithic concrete sewers together with recommended rules for concrete sewer design, both of which were submitted in the nature of a progress report to be printed in the *Proceedings*. Committees on Bridges, on Chimneys and Sidewalks and Floors submitted some comments on their respective subjects and Committees on Standpipes, Fireproofing and Nomenclature reported progress only.

Papers and Discussions

The most important papers of the convention might be divided into two groups—those on tests and those on concrete roads. Of the former class, three were on structural tests, one by A. R. Lord on the long-time test of a flat-slab floor panel in a building, showing surprisingly low stresses even at the end of a year of load; one by W. A. Slater on a built-up flat dome of concrete tile and one by L. J. Mensch on the Bureau of Standards test on cast-iron core concrete columns. The latter was largely descriptive and further information regarding the results must await the Government report. E. B. Smith, of the Office of Public Roads, recounted some further tests on the flow of concrete under load, but confined his paper to the experiments themselves and did not attempt to explain their practical significance. J. G. Steinle explained the field tests made by the engineers on the New York subway concrete work and S. E. Thompson outlined tests on the value of slag as concrete aggregate—tests which on the whole seemed most favorable to that material. A. T. Goldbeck, Office of Public

Roads, had two papers on tests, one to determine the friction value of different types of sub-base for concrete roads, the other to investigate the distribution of a central load over the width of a two-support slab.

The road discussions were naturally all confined to the technique and experience of concrete pavements. Reports were read on current practice as noted in New York State Highways by W. M. Acheson; on the maintenance of Connecticut highways by W. L. Ulrich; on the present condition of the Wayne County roads by A. N. Johnson; and on some of the later construction methods by W. M. Kinney. Abstracts of these papers will be presented together in an early issue of *Engineering News*. Other interesting papers which should be read in full in the *Proceedings* of the Institute are a discussion of contractors' cost accounting by Leslie H. Allen, a report of sane tests on hydrated lime as affecting concrete by Prof. H. H. Scofield, an outlined course of instruction on reinforced concrete by Prof. W. K. Hatt, and a series of papers on ornamental concrete surfaces and products.

Highway Engineers Meet at Boston

The fourteenth annual convention of the American Road Builders Association was held at Boston, Feb. 5 to 9. The Mechanics Building where the sessions were held and the exhibit of road appliances was made was admirably adapted to its uses and furnished better accommodation for the association and its exhibitors than they have ever before enjoyed. With a record-breaking attendance of over 4000, an unusually complete exhibit of road-building materials and equipment and a well-planned program, the convention was a notable success.

The technical sessions began with an outline of the "Policy and Program of the Government in Road Construction Under the New Federal-Aid Law," by Logan Waller Page, Director of the Office of Public Roads and Rural Engineering. The chief object of Federal aid, Mr. Page stated, was to assure a continuous and wise program in the expenditure of all state road funds. There has been some obscurity as to the meaning of the term, "substantial construction" in the Federal-Aid act; this, Mr. Page said, would be interpreted according to conditions and circumstances. There are instances where a sand-clay or gravel road would be considered substantial construction. In the disbursement of Federal aid the initiative must be taken by the state highway department, which must be a real state highway department and not a mere makeshift to act as agent between the Federal Government and the counties. Coöperation is to be the governing principle.

Great interest was aroused by the clause in the regulations for applying Federal aid that none would be given for payment of royalties on patented materials. This started a brisk discussion in which this ruling by the Secretary of Agriculture was both opposed and defended. A resolution was offered by L. D. Smoot, of Jacksonville, Fla., that the Association request the Secretary of Agriculture to eliminate this restriction in granting Federal aid. This was referred to the Committee on Resolutions, which at a later session made a report opposing Mr. Smoot's resolution, and after extended discussion the convention voted unanimously to support the Resolution Committee's action.

At all but one of the sessions of the congress a single paper was read on some type of road construction and all the remaining time was devoted to a general discussion of that type. This program made the sessions very interesting, and the attendance was maintained to the end.

In the session on gravel roads, the fact was brought out that patrol maintenance of this type of road in several states is proving its ability to carry a very considerable motor-vehicle traffic. Hauling gravel in winter by sled is proving economical in Maine and other northern states.

In the session devoted to bituminous roads much interest was aroused in the treatment of "bunches" and corrugation so often found on old road crusts. Attempts to smooth "bunchy" roads by the use of road machines and road planers have not been successful where the crusts are several inches thick. Instances were given where it was necessary to break up these old road crusts by hand, at heavy expense.

The paper of H. E. Breed, Deputy Highway Commissioner of New York, on concrete roads was printed in *Engineering News* of last week. Most New England engineers have done little as yet in building concrete roads and the session was crowded with those who came seeking information. Complaints of team users against bituminous roads on account of their slipperiness and the advantage of concrete roads on account of the better foothold for horses were given much prominence in the discussion.

The relative merits of delivering concrete on the subgrade by a bucket or by a chute were discussed at some length. The chute delivery was opposed because the workmen will make the concrete too wet in order to have it flow down the chute. The bucket delivery on the other hand was claimed to produce hard lumps in the road where each bucketful was dumped.

William H. Connell, in his paper on granite block pavements, said that at Philadelphia he has given up the use of pea stone or gravel in cement-grouted joints, but Worcester, Mass., according to A. T. Rhodes, Street Commissioner, still adheres to this practice with the best of results.

The paper on brick pavements by Fred R. Williams, Engineer of Paving, Cleveland, Ohio, announced that that city has been thoroughly won over to the cement-mortar and monolithic type of construction. Indeed the distinguishing feature of the discussion of brick pavement was the universal advocacy of the monolithic type of construction. If any one present believed a sand cushion was essential to good brick pavement, he did not have the courage to say so. Neither did anyone defend bituminous joints for brick pavements.

The contractors present were given an opportunity to discuss plant and equipment, the initiative being taken by John H. Gordon, a contractor of Albany, N. Y., in a paper on "The Excavation, Manipulation and Transportation of Materials." The most interesting feature in this discussion was the fact that team hauling is still in high favor with many contractors. Motor trucks of 3½ tons capacity were claimed by some to be more efficient than larger vehicles.

The last paper on the program was on the "Traffic Census," by Daniel B. Goodsell, New York City. This paper gave ample evidence that traffic censuses have been made practical use of in New York City, particularly in

TABLE SHOWING COMPARISON OF DESIGNING REQUIREMENTS FOR FLAT-SLAB FLOOR CONSTRUCTION

		* Coef.	Total — %	Total + %	Total Sum	Col. Head Section — %	Mid. Sec. — %	Out. Sec. + %	Inner Sec. + %	Total Sum	
Joint Committee	Drop	.107	62.5	37.5	100	50.0	12.5	28.1	9.4	100	
								to	to		
						50.0	12.5	22.5	15.0	100	
	No Drop	.107	62.5	37.5	100	50.0	12.5	28.1	9.4	100	
						to	to	to	to		
		.107	62.5	37.5	100	40.6	21.9	20.6	16.9	100	
Concrete Institute	Drop	.090	70.0	30.0	100	60.0	10.0	18.0	12.0	100	
			to	to		to	to	to	to		
		.090	60.0	40.0	100	50.0	20.0	28.0	22.0		Not over 100
	No Drop	.090	70.0	30.0	100	60.0	10.0	18.0	12.0	100	
			to	to		to	to	to	to		
			50.0	50.0	100	40.0	30.0	38.0	32.0		Not over 100
Chicago Ruling	4-Way	.087	66.7	33.3	100	53.2	13.4	20.0	13.4	100	Based on Head = 0.225 l.
	2-Way	.093	62.5	37.5	100	50.0	12.5	25.0	12.5	100	
Akme Standards 2-way	Drop	.096	60.0	40.0	100	47.0	13.0	27.0	13.0	100	
	No Drop	.099	57.5	42.5	100	45.0	12.5	30.0	12.5	100	

* Equivalent coefficient "a" in the expression Total Moment = $awl(1 - \frac{2}{3}c)^2$ when c = diameter of round head.

securing legislation for street widening and in traffic regulation. The discussion was largely confined to the injury done various types of pavement by the traffic of the constantly increasing heavy motor trucks.

A resolution expressing the patriotic sentiment of the members in the present international crisis was adopted by unanimous vote and was telegraphed to the President of the United States.

Comparison of Flat-Slab Coefficients Under Different Rulings

The table at the top of this page shows a comparison of the recommendations of the Joint Committee basis for designing flat-slab floor construction, with the proposed Standard Building Regulations of the American Concrete Institute, the ruling of the Chicago Building Department and the "Akme Design Standards" of the Condron Co., of Chicago.

This table was presented in a discussion by T. L. Condron at the recent convention of the American Concrete Institute.

Pipe-Joint Welding Specifications

Some two years ago there was laid for the waterworks of Schenectady, N. Y., about 10,200 ft. of 36-in. lock-bar steel pipe. On being tested after a long delay for the completion of a reservoir, it was found that most of the leaks in the pipe line, which has never been put in use, were in the riveted circumferential joints. As calking did not make these joints tight the city decided to have the circumferential joints welded. Bids for this purpose were received on Feb. 14 by the Board of Contract and Supply, F. J. Bates, Secretary.

The pipe was made from $\frac{5}{16}$-in. and $\frac{3}{8}$-in. plates and there are 137 joints to be welded in the former and 244 in the latter thickness of metal, all single-riveted lap joints. The pipe has an average cover of $3\frac{1}{2}$ ft.

The specifications provide that the welding may be done either by the oxyacetylene or the electrical process, but in either case permanent bottle-tight joints must be secured. All preparatory cleaning, scraping, chipping or other work must be done by the contractor before welding. Separate bids were requested for joint-hole excavations and for joint-hole filling, backfilling, and also for inside and for outside welding by each of the processes named, these bids to be made separately for pipe of each of the thicknesses specified. The city reserves the right to award the contracts for either process of welding and for either inside or outside welding, except that there are a few joints under pavements and also at highways crossings that must be welded on the inside. The city also reserves the right to eliminate the welding of joints on the $\frac{5}{16}$-in. plate if, after the first test, it appears to the engineer that such welding is not necessary.

The joints in the $\frac{5}{16}$-in. metal were made with forty-eight $\frac{3}{4}$-in. rivets, $1\frac{5}{16}$ in. from the edge with $4\frac{1}{2}$-in. lap. The joints in the $\frac{3}{8}$-in. metal were made with forty-four $\frac{7}{8}$-in. rivets, $1\frac{7}{16}$ in. from the edge, with a lap of $4\frac{7}{8}$ in. The pipe was dipped in pioneer coating in the shop and circumferential joints were recoated in the field with a similar coating.

The working pressure to which the pipe line will be subjected is about 150 lb. in the lower and 100 lb. in the upper section. The contractor must recoat joints inside and outside immediately after they are welded unless otherwise arranged between him and the engineer.

The specification requirements as to testing after the welding job has been completed are as follows:

> When all joints to be welded have been welded, the main shall be put into regular service, and if, after 30 days, all welded joints and rivets are bottle-tight and no cracks or other defects caused by the welding process have appeared to cause leaks at any other point on the pipe, the work shall be accepted by the Commissioner, subject to the maintenance provisions hereinafter set forth.
>
> In case of dispute as to the tightness, the engineer may require the main to be tested under a pressure of 200 lb. in the lower section and approximately 150 lb. in the higher section. Under these pressures all visible leaks shall be welded to the satisfaction of the engineer and the total leakage from any section shall not exceed 1½ gal. per lin.ft. of pipe. The leakage from cast-iron pipe tested with steel pipe shall be assumed as 2 gal. per 24 hr. per ft. of lead joint reckoned on nominal diameter of pipe.
>
> These tests shall be applied by the city in the presence of the contractor or his representative, and no claim shall be made by the contractor that his work has been damaged by alleged improper tests.

That the city desires to have the job rushed through is shown by the fact that the specifications require the work to be started a week after the award of the contract and completed on or before May 15, 1917.

The contractor is required to maintain all joints and rivets and any other welding or repairing done by him for a period of one year after the work has been accepted by the commission. The city will retain 30% of the contract price until after the work has been accepted. The contractor must put up a guarantee bond for the fulfillment of the one-year guarantee clause, this bond to be an amount equal to 25% of the cost of the work under the contract.

E. Otis Hunt is Commissioner of Public Works and W. Thomas Wooley is City Engineer.

250-Ft. Concrete Arch Across Spokane River Collapses During Construction

On Feb. 6, 1917, the Post St. bridge, crossing the Spokane River at Spokane, Wash., collapsed without warning while concrete was being placed on one of the arch ribs. Three of the workmen who were carried down in the fall were killed instantly and several others were quite seriously injured. The bridge was to have been a reinforced-concrete twin-rib arch of 250-ft. span and 33-ft. rise. The crown section of the arches was 6x6 ft. and the haunch section 6x8 ft., the spacing of the ribs being 20 ft. c. to c. The twin arches were being erected on framed timber falsework, footing on timber pile bents driven presumably to rock in the river bottom. The concrete was being poured in transverse units with sectional openings between and at the time of collapse the ribs were completed with the exception of one opening on one side of both ribs and the crown key section which was to have been poured last. High water conditions prevailed in the river.

The bridge is midway between, and only 30 to 50 ft. from, the Great Northern Ry. steel bridge and the Washington Water Power Co. steel bridge. It is also near the Monroe St. concrete bridge, the 281-ft. arch in which was for some time the longest in the world.

The bridge and falsework were designed by P. F. Kennedy, Engineer for Olsen & Johnson, the contractors. The erection of the falsework, together with the pouring of the ribs, was in direct charge of Mr. Kennedy until Jan. 31, one week before the collapse, when he either fell or was knocked off the service bridge and was drowned. The general supervision of the work was under the direction of Morton McCartney, City Engineer, and his assistant, B. J. Garnett. Before his connection with the contractor on this bridge Mr. Kennedy had been an Assistant Engineer in the City Engineers' office.

Mr. Kennedy seems to have had exclusive knowledge of the design and construction of the falsework, so that it is difficult to get any information regarding its condition. An analysis of the situation, however, has been made for *Engineering News* by a local engineer, but did not reach New York in time for publication in this issue. A complete description of the failure and of the falsework will therefore appear in next week's issue of this journal.

The two views herewith were taken immediately after the collapse of the structure and show the conditions at each end of the bridge.

FIG. 2. LOOKING TOWARD WEST END OF THE FALLEN POST ST. BRIDGE

FIG. 1. POST ST. COLLAPSE AT EAST ABUTMENT

ENGINEERING SCHOOLS

Massachusetts Institute of Technology

Massachusetts Institute of Technology has arranged a series of lectures and experimental demonstrations in physics, chemistry and applied science for high-school pupils in and near Boston, utilizing the laboratory equipment of various departments. These lectures will be given in the large auditorium at Cambridge on certain afternoons at 4 o'clock. This work will be done through the institute's "Society of Arts," an organization provided for in the institute's charter and which for over 50 years has offered public lectures in popular science.

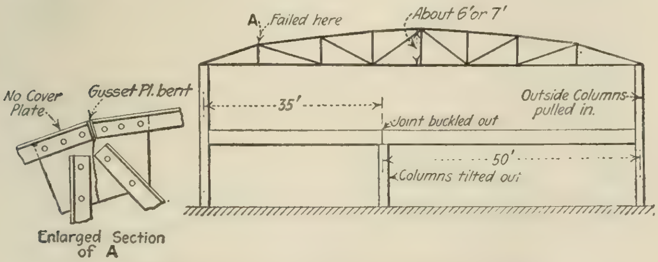
Columbia University

Because of the growth of research work in Columbia University, a plan for the organization of an administrative Board of Research has been placed before the trustees by President N. M. Butler. This board would be separate from the University Council, but responsible to it; its function would be (1) to secure suggestions from departments and individuals for specific researches, (2) to fix the order of precedence in apportionment of available funds, (3) to eliminate duplication of efforts in separate but related departments.

News of the Engineering World

Roof Truss Buckles After Erection When Not Yet Stayed Laterally

A roof truss failed by lateral buckling, Jan. 29, 1917, on the Hyatt-Buick Building under construction in Kansas City, Mo. The building, about 85x130 ft., was two stories high, the second floor being supported on plate girders extending across the building, resting on the outside steel wall columns and on an interior row of columns about 35 ft. from one side. Over the second story were steel roof trusses spanning 85 ft., supported on columns in the outside walls. All the columns and plate girders had been set but no floorbeams were in place. Two roof



DETAILS OF FAILED ROOF TRUSS

trusses had been set, bolted to the columns, and some of the 10-in. channel purlins of the roof had just been placed. These constituted the only lateral bracing in place.

During the noon hour, when no work was being done, the end truss failed by the buckling of the hip gusset-plate (see sketch), followed by the bending of the lower chord angles. This pulled the two outside columns in, forced a kink in the second floor girders, tilted the intermediate first-story columns, and pulled the second truss down. No one was injured and the damage is not great.

The trusses were very lightly built and had no cover plate over the hip joint to give lateral stiffness beyond that furnished by the vertical gusset plate.

Helping Contractors Bid on Road Construction Near Chicago

In preparing to let contracts for 60 mi. of country roads in Cook County, Illinois (in which county Chicago is located), special information has been compiled for the assistance of prospective bidders. A map has been prepared showing the location of sand, gravel and stone supplies in and adjacent to Cook County and giving the name of the owner in each case. This map shows also the railway connections. Another map shows not only the roads and railways, but also the location and car capacity of railway sidetracks in the county adjacent to the roads that are to be built. Thus, a contractor proposing to bid on any particular section can ascertain where and from whom supplies may be obtained, how they can be shipped to the work and where they can be delivered and stored. Blueprint copies of these maps are available in addition to complete plans and specifications for the work.

The roads will be 18 ft. wide (with a top surface or crown of 243-ft. radius) and will have 3- or 6-ft. shoulders, making a total width of 24 or 30 ft. between ditches. Bids are invited on (1) 7-in. concrete (6 in. at the sides and 8 in. at the middle), (2) 2-in. asphaltic concrete on 6-in. macadam base and (3) 2-in. asphaltic concrete on 5-in. concrete base. All the roads are outside the city limits of Chicago. Advertising for bids on individual sections will begin immediately and continue at two-week intervals. The work is under the direction of George A. Quinlan, County Superintendent of Highways, Court House, Chicago.

Syracuse Advised To Adopt a City Plan

The long expected report of B. J. Arnold, of Chicago, to the City of Syracuse, N. Y., on the elimination of railroad grade crossings, has very recently been made. A prominent feature is the recommendation that a definite plan for transportation-line and street revisions be made to accommodate expected city growth. The plan of City Engineer H. C. Allen, for placing the New York Central R.R. tracks from the east in the bed of the old Erie canal and from the west on the West Shore right of way, and changing the passenger station to West Genesee and West St. is approved. The Delaware, Lackawanna & Western R.R. tracks across the city would be placed upon a concrete viaduct. A union station is not recommended as needed at the present, especially as the Lackawanna here is more of a freight than a passenger carrier. The old New York Central station, at Franklin St., would be made an interurban trolley station and public market. The cost of the New York Central work is estimated to be \$6,000,000—\$300,000 for canal lands, \$500,000 for damages, \$5,200,000 for structures and added lands.

Department of Public Domain May Replace Minnesota Board

A department of public domain, consisting of a director under whom there would be five bureaus, each headed by a commissioner, is proposed by a bill now before the Minnesota Legislature. Nine commissions, boards and offices would be abolished and some of the duties of still others would be transferred to the new department as listed in the title of the bill:

State Drainage Commission, State Board of Timber Commissioners, Surveyors General of Logs, Minnesota State Forestry Board, Reclamation Board, Geological and Natural History Survey of the State of Minnesota, State Board of Immigration and the Offices of Commissioners and Superintendents of all State Parks, Forest Reserves and State Forests, and the State Highway Commission, and Conferring the Powers, Duties and Functions of Said Commissions, Boards, Offices and Institutions, and Likewise Such Powers and Duties of the State Auditor (Except as Limited by the Constitution), and of the Board of Regents of the University of Minnesota

as Relate to the Sale, Lease, Improvements, Superintendence and Administration of State Parks, Forests, Mines and the Products Thereof, Except Land on Which State Institutions Are or Shall Be Located.

In addition, some of the duties now performed by the Governor would be transferred to the director of the public domain.

The director would be appointed by the Governor with the approval of the Senate, and after a short term, ending in 1919, would thereafter hold office for six years. The commissioners heading the several bureaus would be appointed by the director for two-year terms. The director would be required to give a bond for $50,000.

The bureaus provided for by the bill are: (1) Land, Forest and Immigration; (2) Mines; (3) Game and Fish; (4) Drainage and Water; (5) Highways. The commissioners of the Bureaus of Highways and of Drainage would be civil engineers. Each of the commissioners would have to be "an expert in such matters" as pertain to his bureau, and "experts now in the service of the state, performing the same or similar duties shall be preferred for appointment." Appointments of all sorts would have to be made regardless of political or other affiliations "and according to a merit system devised and maintained by the director of public domain, designed to effect the greatest practicable economy and efficiency. Subject to the approval of the director of public domain and merit system in force, each bureau commissioner would have the right to appoint and discharge his subordinates and employees.

The commissioner of highways would have all the powers and duties relating to highways or state aid for highways now conferred by law on any state officer or board, including the state highway commission, and the state engineer or secretary of that commission, and his deputies. It would also be the duty of the commissioner of highways "to prepare a plan for a general system of state roads, which may be altered or extended from time to time" but "such plan will require the written approval of the director for the domain." The commissioner would also have power, subject to written approval of the director, to apportion state road and bridge funds among the political subdivisions of the state.

The location and plan for bridges over the Minnesota River now requiring the approval of the Governor would be transferred to the director of public domain.

The bill outlined in the foregoing paragraph was drawn by a commission appointed by the legislature two years ago. It has been indorsed by the present Governor and by the State Drainage Board, which consists of the Governor, the State Auditor and the Secretary of State. The only board or commission that is openly fighting the bill is the State Forestry Board. Some members of the legislature, however, are against the bill on the ground that it places too much power in the hands of one man.

An Engineering Council To Represent the Engineering Profession

Various movements have been started during the past year to effect some form of organization with authority to represent the whole engineering profession in public matters where its interests are concerned. A movement has now been started in New York to have the United Engineering Society, representing the four founder societies of Civil, Mechanical, Mining and Electrical Engineers, organize an Engineering Council, which, according to the plans, will "provide for convenient coöperation between engineering societies for the proper consideration of questions of general interest to engineers and to the public, and to provide the means for united action upon questions of common consent to engineers."

The Engineering Council is to be made up of delegates from such engineering and technical societies as may be invited to join it by the Board of Trustees of the United Engineering Society. Each society which may become a member of the Engineering Council will be entitled to one representative if it has not over 3000 members, and for larger membership it is entitled to an additional representative for each additional 2000 members or fraction thereof. The Council is to consider only matters which are brought to its attention by any of the societies represented upon it. "It may speak authoritatively for all member societies on all public questions of a common interest or concern to engineers, unless objection be made by one-fourth of the representatives."

The general plan of organization above outlined was approved at a meeting held on Feb. 8, at which the principal officers of the four founder societies were present. The proposed plan of organization is to be further considered by the Board of Trustees of the United Engineering Society at its meeting on Friday, Feb. 23, and will come up for final action at a special meeting on Mar. 8.

An Engineering Commission of five unpaid members has been authorized at Atlanta, Ga., to advise the city government on technical matters. Services of members of the affiliated engineering societies have been offered.

A State Health Commissioner for Ohio in place of a State Board of Health is proposed in a bill before the legislature. The Governor would name five members of a Health Council which would make one of its members Commissioner. The Council would have no executive or administrative powers.

A Review of the Flood-Control Plans of Los Angeles County, California, developed by J. W. Reagan, Chief Engineer of Flood Control for the County Board of Supervisors, is likely to be made by a special board of engineers made up of William Mulholland, Chief Engineer of the Los Angeles Water Department, who was named by the Los Angeles Chamber of Commerce; John Quinton, named by the Municipal League, and Homer Hamlin, City Engineer, named by the Finance Committee of the City Council.

A Large Electric Steel Plant with a capacity of 300 tons per day is to be built at Toronto, Canada. The works are being erected by the Imperial Munitions Board on a tract 60 acres in extent in the Ashbridge Bay district on the lake front. The works will contain ten Heroult type electrical furnaces, each taking about 2000 hp. of 3-phase 25-cycle current, which will be supplied by the Provincial Hydro-Electric Commission. Scrap metal will be used as the raw material, and 800 to 1000 men will be employed. Work on the foundations started on Jan. 19, and the plant is to be rushed to completion to supply high-grade steel for shell making.

The Montreal Aqueduct Power Project will be investigated by an independent board of engineers engaged by the City Council. A voluntary commission of rate-paying engineers, local members of the Canadian Society of Civil Engineers (W. S. Tye, Sir John Kennedy, Ernest Marcean, J. A. Jamieson, R. A. Ross, Arthur Surveyer and W. J. Francis), as noted in "Engineering News," Nov. 30, 1916, has reported that the scheme is so unreliable and expensive that the city had better lose the money spent than try to finish the work. About $5,000,000 has been spent out of a possible $11,000,000. The power plant is intended to develop 10,000 hp. The City Engineer has formally disputed the finding of the voluntary board. The new commission is composed of A. St. Laurent, J. B. McRae and H. E. Vautelet.

Sewage Improvements for Detroit, Mich., totaling $8,491,900 are included in the 1917-18 estimates submitted to the City Council by Clarence W. Hubbell, city engineer. This sum would provide for over 30 mi. of sewers and also for a disposal site on Connors Creek estimated to cost $120,000. The complete sewerage program drawn up by Mr. Hubbell to meet the needs of the next few years calls for an outlay of $16,000,000.

PERSONALS

Murray M. Duncan, M. Am. Inst. M. E., manager of the Cleveland-Cliffs Iron Co., Ishpeming, Mich., has been made Vice-President of the company. He is located at Marquette, Mich.

William N. Jones, Assoc. M. Am. Soc. C. E., Engineer of Design and Construction, St. Paul Water Department, has been appointed Engineer in charge of construction at the Minneapolis (Minn.) filtration plant, at a salary not to exceed $5000 per annum.

W. K. Walker, Assoc. M. Am. Soc. C. E., formerly Senior Civil Engineer, Interstate Commerce Commission, Kansas City, Mo., has been appointed Engineer Maintenance-of-Way of the Detroit Division of the Wabash Railway Co., with headquarters at Montpelier, Ohio, in place of R. S. Charles, transferred.

Robert C. Wheeler, Assoc. M. Am. Soc. C. E., has resigned as City Engineer of Summit, N. J., to become Acting General Manager of the Vincennes (Ind.) Water-Supply Co., the Greencastle (Ind.) Water Co. and the New Chester (Penn.) Water Co. He succeeds the late A. W. MacCallum and will have headquarters at 26 South Third St., Philadelphia.

J. T. Collins, Assoc. M. Soc. C. E., formerly Chief Engineer, Department of Public Works, Santo Domingo, has been appointed General Manager of Dominican Government Railroads by the Head of the Military Government, H. S. Knapp, Captain, United States Navy. He will have charge of construction, maintenance and operation of all railroads owned and operated by the Dominican Government.

Henry Welles Durham, M. Am. Soc. C. E., County Engineer of Bergen County, New Jersey, during 1916, and who failed of reappointment during service on the Mexican border, was tendered a dinner on Feb. 3 by certain citizens of the county, interested in a nonpartisan administration and good government. Addresses were made by Mayor Blake, of Englewood, and other public officials.

Harry D. Appleby, former Chief of the Topographic Bureau of the Department of Public Works, Borough of Manhattan, New York City, has been appointed Designing Engineer, Bureau of Yards and Docks, Navy Department, Washington, D. C. He is a graduate of the University of Michigan and for some time was with the Public Service Commission on subway work in New York as an Assistant Designing Engineer.

Gen. George W. Goethals has opened offices for the practice of consulting engineering at 43 Exchange Place, New York City. General Goethals has associated with himself a staff of experienced specialists and will carry on a general consulting practice in civil, electrical, mechanical and hydraulic engineering. It is understood that some of the engineers who have been associated with General Goethals in the Panama Canal work will join him in his practice.

Hugh B. Holmes, formerly Resident Engineer at Kansas City, Mo., of the Kansas City, Mexico & Orient R.R., has been appointed Chief Engineer of the railroad, with headquarters in Kansas City. Mr. Holmes entered railway service in 1899, with the Chicago, Burlington & Quincy R.R., as a rodman. He began service with the Orient R.R. in 1900 as topographer on preliminary surveys in the State of Chihuahua, Mexico; afterward serving as levelman and transitman on location. In 1904 he was Resident Engineer on the construction of the first 20 km. of the La Junta-Temosochic extension of the Chihuahua & Pacific Ry. (now the Mexican Northwestern Ry.). He reëntered the service of the Orient in 1905 as Chief Clerk and Assistant to the Superintendent of Construction at Chihuahua, in which capacity he served until 1909. In 1912 he was appointed Resident Engineer in charge of the engineering department of the receivers of the railroad.

Dr. W. F. M. Goss, M. Am. Soc. M. E., Dean of the College of Engineering, University of Illinois, has resigned, effective Mar. 1, to become President of the Railway Car Builders' Association, which is made up of representatives of 15 different companies engaged in the manufacture of railway cars. The object of the association is to establish coöperative relations between manufacturers and purchasers and especially in the matter of standardizing design and specifications. Dean Goss organized the Department of Practical Mechanics at Purdue University in 1879. He was Instructor, Professor and Director of the Engineering Laboratories there until 1907, when he went to the University of Illinois. He was in charge of the locomotive-testing plant of the St. Louis Exposition in 1904 and has served as Chief Engineer of the Commission on Investigation on Smoke Abatement and Electrification of Terminals at Chicago, Ill. He is a past-president of the American Society of Mechanical Engineers.

OBITUARY

Thomas M. Bannon, engineer, Topographic Branch, United States Geological Survey, died on Feb. 4 in Baltimore. He had been connected with the Survey since 1888.

Frank H. Martin, an architect and member of the firm of Martin & Hall, Providence, R. I., died at his home, on Feb. 2, from pneumonia. He was 53 years old.

Roger Kennedy, a Connecticut contractor, died at South Farms, Ind., from apoplexy, on Feb. 6. He is said to have built many of the docks along the Connecticut River. He was born in Ireland in 1847.

Charles T. Schoen, reported as the originator of the pressed-steel car now in general service on railways, died in Moylan, near Philadelphia, on Feb. 4, at the age of 72. When 20 years old he became manager of a spring factory at $12 per week. It is said that the next year he was raised to $30 and given a fifth interest in the profits, amounting to $17,000. In 1889 he designed his pressed-steel car.

Samuel Forsythe Thomson died after a short illness at his home in Brooklyn Borough, New York City, Jan. 30, 1917, at the age of 44. He was born at Charleston, S. C., June 5, 1872. After graduating from the Massachusetts Institute of Technology in 1896 he took service under Col. George E. Waring, Street Cleaning Commissioner, New York City. He then went to West Point as an instructor in civil engineering. After several years in that capacity he returned to New York and entered the service of the Rapid Transit Railroad Commission, being assigned as assistant engineer on the construction of the East River tunnels of the Interborough System under Division Engineer Robert Ridgway. In the spring of 1906, soon after the Board of Water Supply of New York City was organized, Mr. Thomson, again serving under Mr. Ridgway, went on to the Walkill Division of the Catskill Aqueduct, where he remained throughout the entire construction of that portion of the aqueduct, first as assistant engineer and then as acting division engineer in charge of the work. The value of the construction work on this division was approximately $6,000,000. The last three years of his life he spent in New York City with the Kingsbridge Contracting Co. as engineer on several large sewer contracts.

George Henry Hill, M. Am. Inst. Elec. E., a member of the engineering staff of the General Electric Co. at Schenectady, N. Y., died on Jan. 31 after a brief illness from pneumonia. Mr. Hill was born at Williamsport, Penn., in 1872. He received his education at Dickinson Seminary and Johns Hopkins University. He graduated from the latter institution in 1895 and took up work with Frank J. Sprague on the development of electric elevators and multiple-unit control for railway trains. He soon became chief of construction of the elevator department, and when this class of work was relinquished by the Sprague company in 1900 he became chief engineer of the company's works at Bloomfield, N. J. In 1902, when the Sprague patents were taken over by the General Electric Co., Mr. Hill joined the forces of the latter company and had responsible charge of the further development of multiple-unit train control. As assistant to S. E. Case, he had charge of the manufacture of the car equipment for the elevated and subway lines in New York, Boston, Chicago and Philadelphia, as well as much work for foreign countries. Since 1906 Mr. Hill has been Assistant Engineer of the railway and traction department, and was in charge of the group of engineers dealing with the general problems arising in connection with electric-railway development. In this position he was one of the company's most important advisers. Mr. Hill made many important inventions in connection with his work, taking out over 40 patents. Among these was a broad patent on the system of electrically operating bulkhead doors in ships. Mr. Hill had been a frequent contributor to technical journals and to the "Proceedings" of the American Institute of Electrical Engineers, which he joined in 1899. He was chairman of the Schenectady section of the Institute during 1915. Mr. Hill was married in 1899 to Miss Hazel Thompson, of Bloomfield, N. J., who with three sons survives him.

ENGINEERING SOCIETIES

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb 19-22. Meeting in New York City. Secy., Bradley, Stoughton, 29 W. 39th St., New York City.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-21. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb 20-21. Annual meeting in New Haven in Mason Laboratory. Secy., J. F. Jackson, New Haven.

IOWA STATE DRAINAGE ASSOCIATION.
Feb. 20-21. Meeting in Fort Dodge. Secy., M. F. P. Costelloe, Ames.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting in Ames. Secy., J. H. Dunlap, Iowa City.

AMERICAN CERAMIC SOCIETY.
Mar. 5-8. Annual meeting in New York City. Secy., Edward Orton, Jr., Columbus, Ohio.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Mar. 5-10. Annual meeting in New York City at McAlpin Hotel. Secy., T. A. Randall, Indianapolis.

CENTRAL ELECTRIC RAILWAY ASSOCIATION.
Mar. 8-9. Annual meeting in Indianapolis. Secy., A. L. Neereamer, Indianapolis.

NEW ENGLAND RAILROAD CLUB.
Mar. 13-17. Annual meeting in Boston. Secy., W. E. Cade, 683 Atlantic Ave., Boston.

WISCONSIN ELECTRICAL ASSOCIATION.
Mar. 15-16. Convention in Milwaukee. Secy., George Allison, First National Bank Building, Milwaukee.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 20. Annual meeting in Chicago at Coliseum. Secy., C. W. Kelly, Kelly-Derby Co., Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 21-22. Annual meeting in Chicago. Secy., Horace H. Clark, 1325 Edison Building, Chicago.

The Oregon Society of Engineers held its annual meeting on Feb. 5 at the University Club, Portland, the occasion being a "dollar dinner."

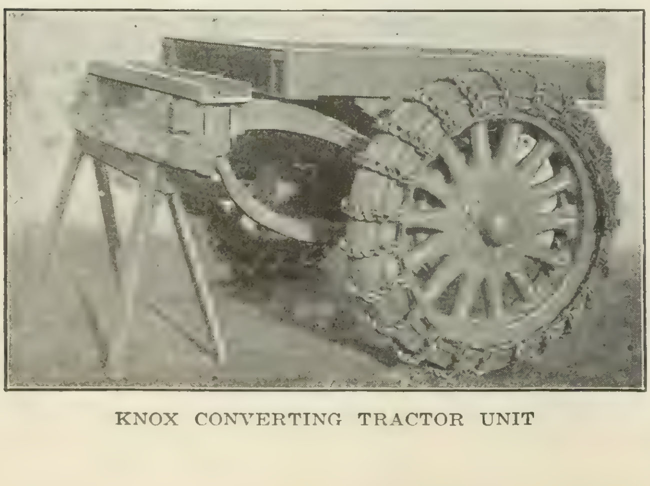
The American Chemical Society will hold a spring meeting in Kansas City, Apr. 10 to 14. In addition to the business and technical sessions, there will be a smoker, a banquet and excursions. The secretary is Charles L. Parsons, Box 505, Washington, D. C.

The North Dakota Society of Engineers, at its annual meeting Jan. 30 and 31, elected the following officers: President, J. A. Ingram; vice-presidents, R. H. Slocum and J. H. Clarke; secretary, E. S. Chandler, University, N. D. The proposed law for the licensing of land surveyors, previously prepared by the society, was modified slightly and again submitted to the Legislature. It provides for the examination (and licensing upon proof of qualifications) of land surveyors in the state, and provides that none except licensed surveyors shall be allowed to hold the office of county surveyor, or to issue surveyor's certificates or certified plans or plats for filing, in any case where the location of property lines is thereby involved. The next annual meeting will be held at Fargo.

Appliances and Materials

Tractors Made from Pleasure Cars

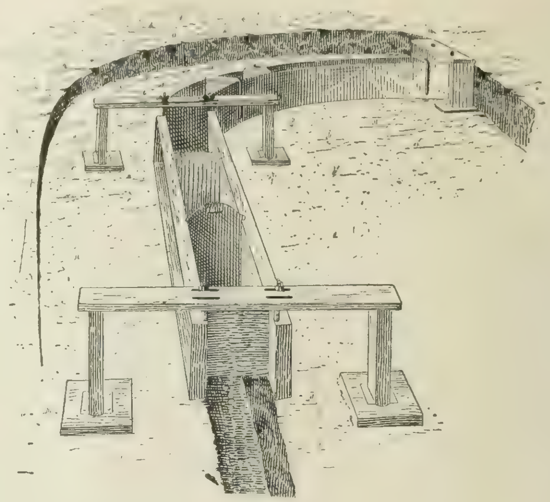
The Knox Motors Co., of Springfield, Mass., has designed a traction unit that converts a pleasure automobile into a three-ton tractor. It is aimed by this to provide a use for the thousands of second-hand cars coming upon the market each year and for which there now seems to be no outlet. This device replaces the rear axle and wheels and the rear part of the body. The unit has the spring suspension of the regular Knox tractor for the end of the car frame, and the heavy weight of useful load is transferred directly to the new rear axle through a separate set of springs. The cross-channel of the unit is bolted to the frame of the car, and the propeller shaft is connected to a universal-joint flange on the drive-axle internal gear. After hooking up the brake rods the tractor is ready. Where a dray is used as a load carrier, a special bolster is fastened on the front end (the wheels and tongue being removed) and connected with the tractor turntable. This unit sells for $550.

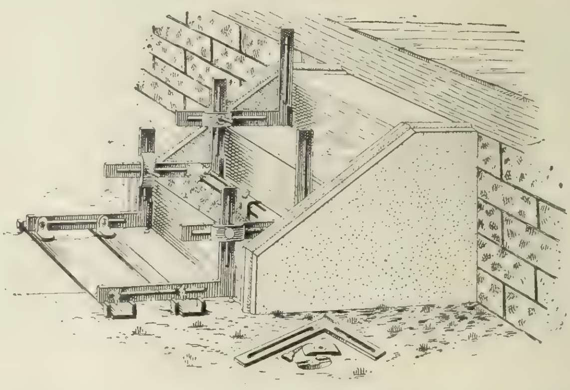


KNOX CONVERTING TRACTOR UNIT

New Curb and Step Forms

The steel form for concrete curbing shown herewith is suspended from above instead of being supported from below in the more usual way. At intervals are placed posts or stools carrying crosspieces having slotted holes to receive bolts on the top of the form plates. Wing nuts on these, and resting on the crosspiece, provide for adjusting the elevation of the forms. Transverse clamps, shown on either side of the middle support, keep the side plates in proper position. Between the first support and the first crossclamp is a templet with handhole. This is left in place while the concrete is being deposited and is then removed, leaving a joint in the curb.





SUSPENDED FORM FOR CONCRETE CURBING AND NEW FORM FOR STEPS

The form for concrete steps is composed of a series of L-shaped arms, with each side slotted to receive clamping bolts. The bottom arms are set on anchor plates carefully leveled, so that no further plumbing or squaring is required in setting the additional arms for the side frames. Between the side arms is moved a strike or templet, which is made telescopic so as to be adjustable for various widths of steps. It is made of a pair of angles, with slotted holes for clamp bolts. This templet moves on guides under the side arms, these being adjusted to give the desired slope for the surface of the step. The slotted L-frames are used also for curb forms.

These curb and step forms are among the specialties of the H. D. Cornelius Co., 3012 Calvelage St., Cincinnati, Ohio.

Engineering News

VOLUME 77 FEBRUARY 22, 1917 NUMBER 8

Ship Canal from Swedish Lake to Ocean

A barge or ship canal connecting one of the large lakes of Sweden with an ocean port has just been completed, after seven years of work. The canal is known as the Trollhattan Canal and connects Lake Vener, in the southwestern part of Sweden, with the port of Gothenburg, which is located on the Cattegat, the strait connection between the Baltic and the North Sea. The project was started by investigations in 1902, and actual construction was begun in 1909. Official ceremonies opened the work in October, 1916.

The new canal, which is an enlargement of one of some years' standing, is 52 mi. long, 47 mi. of which is the canalization of the Gota River. From the lake to the sea level there is a difference of head of 145 ft., which is distributed among six locks. The canal is designed at present to carry vessels of a draft of 13.2 ft., though it is eventually intended to be deepened to carry vessels of a draft of 16.4 ft. On account of the eventual depth, a number of the rock excavations have been carried down to the full depth, and the locks have been built for future contingencies. The minimum bottom width of the canal is about 80 ft., with wide turnouts provided at intervals. The excavation in rock is on a slope of 10:1 and in earth on a slope of 1:2. The minimum width of the lock gates is 45 ft., and the length of the lock chambers is 296 ft. The minimum depth over the sill of the locks is 18 ft.

FIG. 1. LOOKING DOWN A FLIGHT OF THREE LOCKS AT TROLLHATTAN, ON THE TROLLHATTAN CANAL IN SWEDEN

Excavation totaled about 5,390,000 yd., distributed as follows: Soil excavation, 930,000 cu.yd.; total rock excavation, 1,360,000, of which 34,000 is below water; dredging, 3,100,000 cu.yd.

Six locks are required to take care of the difference in head, two of them at either end of the canal and four at the town of Trollhattan, the site of the famous water-power development. Of these four locks, three are joined in one flight. The view in Fig. 1 is taken from the uppermost of the three locks, looking down toward the lower level. The locks vary in difference of level from 18 to 31 ft. They are of concrete masonry; but in some cases where they are built through the solid rock cut, the side against the rock is not completely sheathed with concrete, but is merely provided with piers on which guard timbers are placed. This is very well illustrated in Fig. 1.

The lock chambers can be supplied with and emptied of water by lateral culverts arranged in the masonry on the sides of the gate chambers. These culverts are placed on either side of the lock basin, as a rule, and inlet culverts open into a crib arranged under the upper gate chamber in each lock. From this crib a bottom channel leads under the bottom of the lock, from which the water flows out into the lock. Outlet tunnels proceed likewise through the bottom channel. The flow of water in the lateral culverts is regulated by vertical valves. When it is necessary to repair the valves, the lateral culverts can be shut off separately by means of sliding timbers. The lock gates are mitered and are driven, like the valves, by means of electric machinery placed in the chambers in the lateral masonry and sunk under the plane of the lock. The locks are moreover provided with electrically driven capstans, windlasses and other operating machinery, with appliances for shutting off the locks and with electric illumination and signalling apparatus. All the electric machinery, except the capstans, and all the illumination and signal lights are operated from boxes erected on the lock planes.

While it is expected that some self-operated boats will run in the canal, in order to facilitate the towing of sailing vessels and barges a towpath has been arranged

FIG. 2. THE TROLLHATTAN IRRIGATION CANAL IN SOUTHWEST SWEDEN
The navigation canal on the left, the power canal in the middle and the Gota River in the rear

along one side of the canal. Full provision for navigation has been made in the way of signals, lighthouses, drawbridges at the principal railway and road crossings, harbors at the different towns that are passed, breakwaters in the lakes, and regulating dams at two places.

Fig. 2, taken at Trollhattan, shows the completed canal as it appeared last fall. The navigation canal is to the left, the famous Trollhattan power canal is in the middle of the picture, and the river is in the background. One of the harbors, that at Akersberg, is shown in Fig. 3.

The superintendence for the entire work was in the hands of the Director-General of Waterfalls of Sweden, Col. F. Z. Hansen. The immediate construction was under charge of Capt. G. Maln, of the Corps of Royal Engineers, and later of Lieut. A. Ekwall, of the same corps, who succeeded Captain Maln in 1914. The information on the canal, together with photographs, some of which are reproduced here, was kindly forwarded to us by K. A. Froman, the chief assistant engineer of the canal work. Mr. Froman's report also states that by a bill passed late last year the Swedish Parliament voted a grant for the beginning of the extension of a canal connecting the Baltic and Lake Malar, at one end of which Stockholm is situated. When the reconstruction of this canal has been completed, the two largest lakes of Sweden will be accessible to modern seagoing vessels. A further project that is under consideration is the building of a canal connecting Lake Malar with Lake Vener.

FIG. 3. A DOCK AND LOCK BASIN ON THE NEW TROLLHATTAN SHIP CANAL IN SWEDEN

The Art of the Expert Witness

SYNOPSIS—A well-known engineer who has appeared as an expert witness in many court and informal cases, here writes his observations on securing good testimony that will win the satisfaction of clients and the respect of opponents. This article deals with the engineer on the witness stand in court. A subsequent article discusses differences in opinions and findings of fact between experts.

I. On the Stand

Nearly all engineers are called upon sooner or later to speak as experts in connection with some engineering matter. Expert testimony is a subject on which very little has been written. It appears that engineers equally qualified in other respects differ greatly in their ability or effectiveness as expert witnesses. There is no reason why engineers should not seek to attain the highest possible efficiency as expert witnesses when called upon to act in that capacity, just as they would seek to attain the highest efficiency in engineering design or construction work.

Possibly the use of the word efficiency, applied to the work of an expert witness, is somewhat novel; therefore, the following definition is given:

Efficiency on the part of an expert witness is the ability to get before the court or judicial body the facts or opinions involved in his testimony—clearly, correctly, completely.

What the Expert Is For

It is a fact that many excellent engineers make very poor expert witnesses. Probably in large measure this is due to failure of the engineer when appearing as a witness to realize the peculiar conditions under which he is then working. First, the witness is presenting the results of his studies or experience, not to engineers, but to men whom he must assume are wholly ignorant of technical matters and whose whole mental processes are different from his own.

In the second place, he must bear in mind that he is not at liberty to state his opinions in what very likely appears to him to be a natural, orderly and consistent manner, but rather he must get his testimony before the court in answer to a series of questions which may come to him in a very different order from that in which he would ordinarily make his own statements.

Above all, the expert witness must constantly bear in mind that his testimony is being presented for the information of the court; that the court, as a rule, has a high degree of intelligence and is not hampered by prejudice for either side; but that it is not a technical court and requires very clear, and often full, explanations of technical matters in order to grasp their proper significance and bearing.

Knowledge and Ability

There is another and a different reason why many excellent engineers do not make good experts. Success in engineering, as in many other things, is often attained mainly through concentration. The engineer who has devoted himself exclusively, we will say, to some specific class of work in a particular locality, however successful he may have been, may make a very poor witness as to general principles and facts and conditions underlying the design, efficiency or cost of similar work elsewhere.

The reason is that an expert to make a good witness must, in general, be very broadly conversant with the subject with which he is dealing. He must be capable of distinguishing instantly between broad generalities and specific instances. The man whose work has been concentrated along a certain line is much less apt to possess this ability than one whose practice has been perhaps more superficial, but which has covered a wider range and consequently enables him to view from a variety of different angles every possible question involved.

A primary requisite of success as an expert witness appears to be therefore a broad and thorough knowledge of the subject upon which the witness is appearing. There is nothing that can give a witness a greater degree of self-possession or fuller confidence as he squares himself for cross-examination on the witness stand than the feeling that he knows what he is going to talk about and knows it better than anyone else present—better than the attorneys who cross-examine him can possibly know it.

Even if the witness possesses in full the qualifications of knowledge and experience, he will often leave the witness stand, after his first experience, with a feeling of great dissatisfaction, especially if the opposing counsel who cross-examines him is sharp and subtle. As in most other lines of personal effort, a high degree of efficiency can be attained only as the result of practical experience. Given the primary qualifications of knowledge, ability, self-control, a certain amount of adroitness and a good understanding of human nature, still the engineer appearing as an expert can, if he will, profit greatly along the following lines as the result of experience. A little study will quicken the process.

Rules of Evidence

He may learn much of the rules of evidence, so that he will know when to qualify and when not to qualify his answers. He may learn the art of making his answers complete and unequivocal and at the same time direct and wholly responsive. On cross-examination some questions call for yes or no answers, and others do not. Questions that can fairly be answered by yes or no should in general be so answered. The witness who unnecessarily qualifies his answers runs the risk either of creating an unfavorable impression with the court, or of having portions of his answers striken out as not responsive.

On the other hand if, as often happens, the cross-examining attorney is attempting to create a false impression by a series of questions, then a qualified answer is not always unjustified. Even if afterward stricken out, it may call the attention of the court to the unfairness of the questions.

Circumstances alter cases. An expert witness subjected to unfair questions sometimes properly takes the bit in his teeth and runs away with the cross-examining attorney. The latter has the power, by virtue of his position and under the rules of evidence, of mistreating an inexperienced but fair-minded witness. Certainly, a fair-minded witness is entitled to resort to somewhat extreme methods

to protect himself against browbeating and insinuation. Judges seem generally to prefer that a witness should take care of himself rather than continually appeal to the court for protection.

The object of qualifying an answer is to put the truth in its proper relations. A witness is asked to state the minimum flow of a stream, where it is evident that the natural or unregulated flow is intended, but is not so stated in the question. The witness may have seen the stream dry under artificial conditions, and there are therefore two answers that he may give. Answering literally, he may say zero. Assuming that the intent of the question is to get at the natural minimum yield, he may give the latter figure. Either answer is likely to lead to complications. The question, as put, is at fault because it does not clearly distinguish which is intended—the natural or the artificial minimum. The witness should either clear this up by asking a question preliminary to his answer or else should qualify his answer by stating to which it refers.

If a witness cannot answer a question in such a way as to tell the whole truth by the word yes or no, he is entitled to say so. Nevertheless, the presiding judge not infrequently will be of the opinion that the question is one that may fairly and properly be answered by yes or no and insist upon such an answer. Under these conditions there is no reason why a witness should not supply the answer, for it is already on the record that his answer is under protest, implying that there is some qualification necessary. The witness must, however, depend upon the counsel for his own side of the case to give him an opportunity to make the desired qualification to his anwer later on, on redirect examination. Some attorneys seem never to miss an opportunity to engage in a so-called fishing expedition in the cross-examination of an expert, while others confine their cross-examinations to brief and pertinent matters and, following the advice of an old trial lawyer, "do not attempt to plow with their adversaries' oxen."

Definiteness To Be Sought

Another point where inexpert witnesses often fall short is in the matter of definiteness. Testimony that a certain distance is a long distance, or that a certain well is a deep well, is bad enough even when coming from lay witnesses. Attorneys on both sides often try in vain to get witnesses to give definite statements in such cases. The experienced expert witness will know beforehand that he is quite certain to be called upon for a definite statement; he will give the matter forethought and be prepared. But suppose that the witness has not done so and does not actually know, for example, the distance between two points. One of the attorneys will ask him to give his best judgment. Perhaps the witness will say he does not know and has no judgment. Still the attorney may persist, "Well, you know it is not a hundred miles, don't you?" and the witness will reply, "Yes." Then the attorney will ask: "Is it more than one mile?" and the witness will reply "Yes." Proceeding by successive increments, the attorney will worm out of the witness a guess as to the distance involved. Very likely, when the opposing counsel's turn comes he will ask: "That was nothing but a guess?" to which the witness will say, "Yes." The net result is that a great deal of time and labor has been expended in getting the witness to give an answer that he might as well have given as a guess, so stated, in the first instance.

There is another class of judgments that a witness is often called upon to give upon the witness stand which deserves some attention, and that is estimates on matters capable of measurement, but which the witness, owing to his special knowledge or experience, is competent to estimate closely without actual measurements, such, for example, as the amount of masonry in a wall that the witness has examined carefully, but has not measured.

Having given his estimate, the opposing counsel is very likely to insist upon an admission by the witness that this estimate is purely a guess. In general, such an admission should not be made. The witness should have clearly in mind the distinction between guesses, estimates and actual measurements.

The mathematical definition of a guess is: A judgment that the probability of an event lies midway between the two possible extremes, made in the total absence of any knowledge of causes tending to vary it one way or the other. It is the value of the event that would have a probability of one-half in accordance with the principle of insufficient reason.

An estimate is a judgment of the most probable value of an event or a quantity where there are some known elements that may affect the position of its value between the possible extremes, all these elements being taken into account. Precisely speaking, of course, a guess is a judgment and so is an estimate; but practically, a guess is never an estimate, although estimates vary in value from those which are only as good as guesses to those which are nearly equal to actual measurements.

As illustrating the difference between guesses and estimates, let it be required to determine the distance between two points that lie somewhere within a circle 2 ft. in diameter. The points cannot be more than 2 ft. apart, and they may be in juxtaposition. If their locations are wholly unknown, the best possible guess as to their position is that they are 1 ft. apart. If their location is known, but the distance between them has not been measured, an estimate of the distance may often be made that will be very close to the truth, by comparing their apparent distance with some fixed scale or unit of measurement, such, for example, as the diameter of the circle. Thus an estimate is based upon some scale of comparison, while a guess is not so based.

Calculations Made on the Stand

Many experts absolutely refuse, unless compelled by the court, to make calculations on the witness stand. If the expert has before him the necessary data and the calculation is one that can be quickly made, there is no reason why he should refuse to make the calculation on the witness stand. But when undertaking so to do and before giving the result, he should request permission to correct the figures if upon checking them over at his leisure he finds any errors or matters that he desires to change. This creates a much better impression than to refuse to make any calculations whatever. The writer has seen an alert judge or opposing counsel make a calculation, and make it correctly, while an expert who had been asked to make a calculation on the stand was arguing about the great length of time it would take and the impossibility of making the calculation in court.

Some experts make a practice of destroying, or leaving at home, details of the specific calculations on which their opinions or valuations are based. This practice may sometimes shorten cross-examination, but it is very unfair to

the court, which is the party often most interested in knowing the manner by which the opinion was reached. The value of an opinion depends very largely on the foundation upon which it rests. An opinion that is deduced from stated facts by a logical process of reasoning or by definite mathematical calculation is entitled to more weight than a mere floating unattached hypothecation.

Knowledge of the Law

If underlying data are asked for and it appears that they have been purposely withheld or destroyed, a court is justified in giving the testimony based thereon scanty consideration. At the same time, an expert whose opinion is the result of previous experience in many similar cases cannot be expected to carry his entire professional history around in a brief case. An intelligent witness, as well as an intelligent judge, will determine readily what it is pertinent to produce in response to the cross-examining attorney's requests.

Experts as well as lay witnesses often find difficulty in distinguishing between direct and hearsay evidence. The opinions of an expert should be his own, but the facts may be derived from others. Thus an expert may take, and it is often his duty to take, account of facts which of themselves would be hearsay and incompetent.

Thus in valuing real estate it is proper for an expert to inquire diligently as to sales of similar and adjacent properties, the prices and attendant conditions, and to utilize this information in forming his opinion of value. Yet these prices and conditions are wholly incompetent as direct evidence of value of the property in question, although they may be brought into the record through cross-examination if the opposing counsel so elects, and accordingly the witness should be prepared to give them when called for.

Similarly, the witness may consult authorities as to general practice or as to historical conditions, and he may base his opinion thereon to some extent. Yet he must be sufficiently conversant with the subject to be able to form an opinion of real value, and it must be his own opinion that he gives—not that of some authority he has consulted.

In general, an expert cannot be permitted to bolster up his opinion by citing authorities on direct examination, but he may be asked on cross-examination to cite some authority for an opinion he has given. Authorities may be cited to the witness on cross-examination for the purpose of controverting the opinions he has given. In general, the witness will first be asked if he accepts the work of such or such an author as an authority on a certain subject. An expert may accept a certain authority as a whole or in part or on certain subjects and not on others. Few so-called authorities are wholly correct, and fewer still are wholly wrong.

Some knowledge of technical matters is admittedly of value to an attorney engaged in the trial of technical cases, and attorneys do not hesitate to utilize such knowledge in questioning witnesses. An engineer likewise may be better capable of assisting the court by virtue of the possession on his part of some knowledge of fundamental principles of the law underlying the subject in hand. This is especially true for example in land-title and boundary cases. The use of such knowledge in preparation of technical evidence or in formulating answers to questions on the witness stand does not necessarily involve the adoption of the rôle of advocate on the part of the expert nor the usurpation of the functions of the court.

It is a most common practice among attorneys on cross-examination to attempt to prove an expert witness inconsistent by producing his evidence in some other case and seeking to show that opinions he there presented controvert the ones he is giving. In such practice the opposing counsel as a rule carefully avoids giving the witness any opportunity to explain the differences in conditions in the two cases; and it may happen that there is not the slightest inconsistency in the testimony of the expert in the two cases, when the attendant conditions are considered.

In such an instance the expert must rely upon his counsel to secure an opportunity to make the necessary explanation or statement of the distinguishing factors in the two cases. In general, it does not appear that lawyers gain much by such practices unless the contradiction is clear and the conditions identical.

Language; Hesitation; Advisory Experts

Perhaps it is unnecessary to say that nothing can be more helpful to the expert on the witness stand than clarity of thought and the ability to use in a masterful manner the language in which he is speaking. The witness needs perspicuity as well as perspicacity. If anything, it is the most important of the two.

The witness may and should take the necessary time to think before he answers a question. On the other hand, for a witness to hesitate too long before answering often creates the impression that the witness is stalled or uncertain. If the witness is as thoroughly qualified as he should be, he does not need much time in which to formulate an answer to a clear and fair question; and again, if the question is not clear or fair, he does not need much time in which to state that fact to the court.

An engineering expert is often called upon to sit in with the attorneys during the trial of a case, to offer suggestions in technical matters generally and to assist in the cross-examination of opposing experts. Here, especially, some knowledge of the rules of evidence is of value. It will greatly aid the consulting expert in properly framing questions to be asked by counsel. It is highly important, especially where counsel is not fully conversant with the technical questions involved, that questions written out and handed to him for use in cross-examination should be competent, material and relevant, since a change in form may render the question ambiguous or even absurd.

Leading questions in general are permissible on cross-examination; and if the opinion offered by an opposing expert appears to be too restricted or too broad, the truth may often be arrived at on cross-examination by either extending the principle or else reversing the principle.

For example, in one action a so-called hydraulic expert testified that placing flashboards 10 in. high on a certain dam would raise the water level 3 ft. at a point 10 mi. upstream. The cross-examining attorney, wholly ignorant of hydraulics, doubted this evidence; he was by no means sure of its untruth, but he realized that if it was true it was fatal to his case. Therefore, it was important to controvert it. The result was readily accomplished by reversing and extending the principle. The river was 7 ft. deep and the dam was 8 ft. high. The witness was easily led into the admission that if his evidence was true, then lowering the dam 30 in. would dry up the river, an obvious absurdity.

Cincinnati Motor Racetrack

By George C. Mills*

The latest addition to the list of 2 mi. automobile racetracks is located near the north boundary of Hamilton County, Ohio, on the Dayton pike, about 14 mi. from Fountain Square, Cincinnati.

This is an oval track with tangents 1,826.35 ft. long and 180° curves of 3,415.65 ft. length; the tangents are parallel. The elements of the alignment are shown on the accompanying plan, Fig. 2. The curved portion of the track was developed from straight segments.

The track is 70 ft. wide. The flooring is 2x4-in. yellow pine, 14 ft. or over in length, dressed on one side and one edge, except where beveling is required owing to the curvature of the track. The flooring is laid loose on the track timbers with the exception of that portion forming the guard rail on the outside of the curve, which is spiked to the blocking. The first two strips on the inside of the track are also spiked together and to the bearing timbers.

The floor strips are laid with joints well broken; each strip is spiked to the adjoining strip with 20d. wire-cut nails, driven laterally, leaving 1/4 in. at the head of each nail exposed to form spaces between the strips. These nails were driven 12 in. between centers and were staggered.

The sides of the flooring strips are beveled to maintain the spacing at the surface of the track when required by curvature of the cross-section. The curved cross-section of the track was developed from a true arc of a circle with timbers cut accordingly. The superelevation at the middle point of the turn is 26 ft.

A safety run of well-rolled earth encircles the field immediately inside the track. This is graded in cut or fill to the same level as the inside edge of the track, rising 6 in. toward the infield. The width varies from 10 ft. on the straightaways to 20 ft. on the curves, except in front of the grandstand, where concrete paving is provided to a width of 20 ft.

The topography made necessary a moderate amount of grading. The inner edges of the two stretches of straightaway rise uniformly from El. 593.0 at the P.C.'s on the west end to El. 596.0 at the P.C.'s on the east end. Beneath the track the ground is graded to leave a clearance of not less than 2 ft. from the top of the ground to the finished surface of the wood flooring; and where

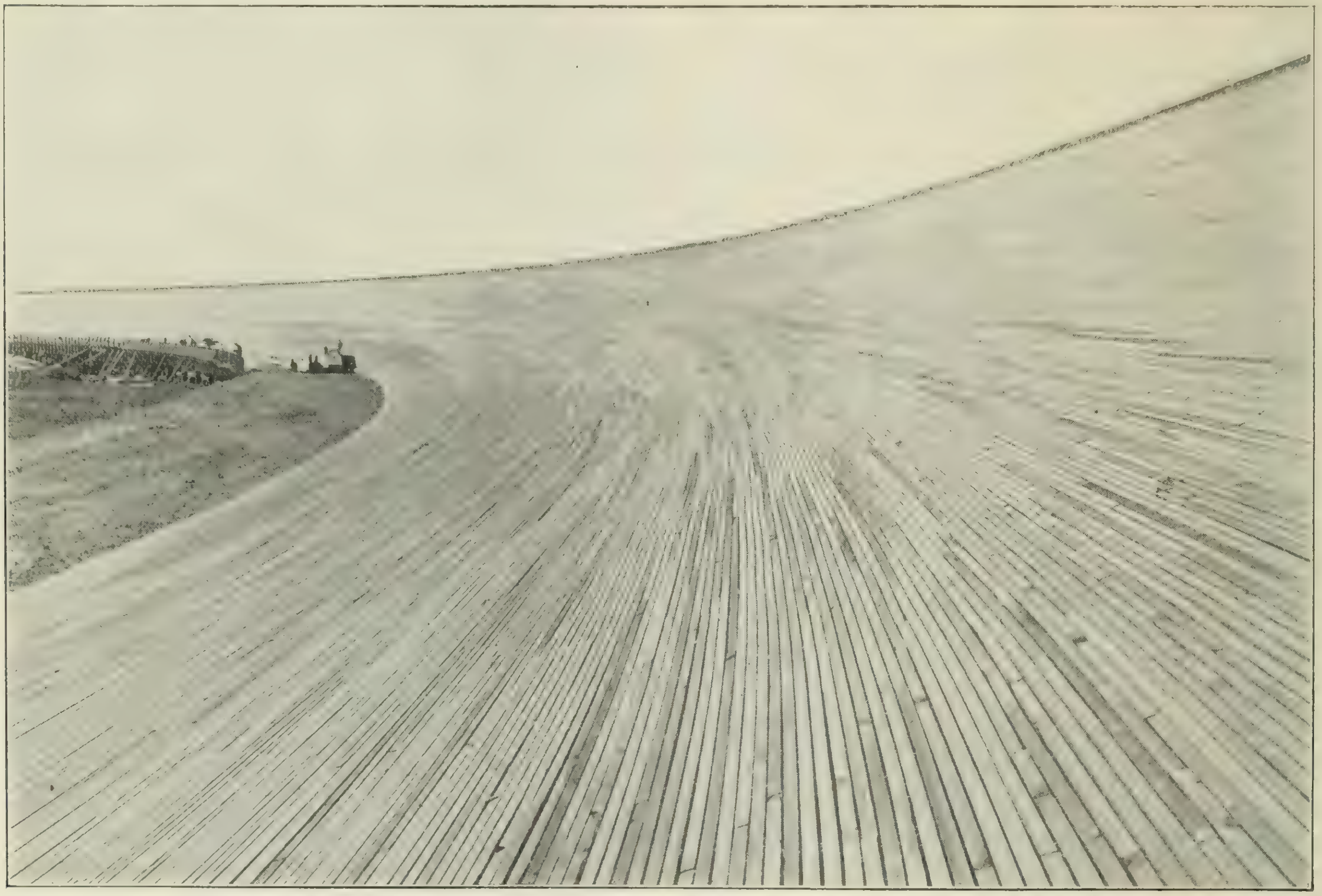


FIG. 1. VIEW ON A BANK OF TWO-MILE MOTOR RACETRACK AT CINCINNATI, OHIO

the ground outside of the track is higher than the track, a terrace is formed and a drainage ditch excavated.

A concrete tunnel under the track opposite the entrance to the park provides access to the parking spaces on the infield. All piers and footings for the stands and track, the repair pits opposite the grandstand and the paving of the safety run opposite the grandstand are also of concrete. The track is inclosed by wire fencing, 8 ft. high, of Nimmo design, excepting where the superelevation at the outside of the curves renders fencing unnecessary.

The grandstand and bleachers have each a seating capacity of 15,000. About 4,000,000 ft. b.m. of lumber was used in the construction of stands and fence around

*Civil Engineer, Cincinnati, Ohio.

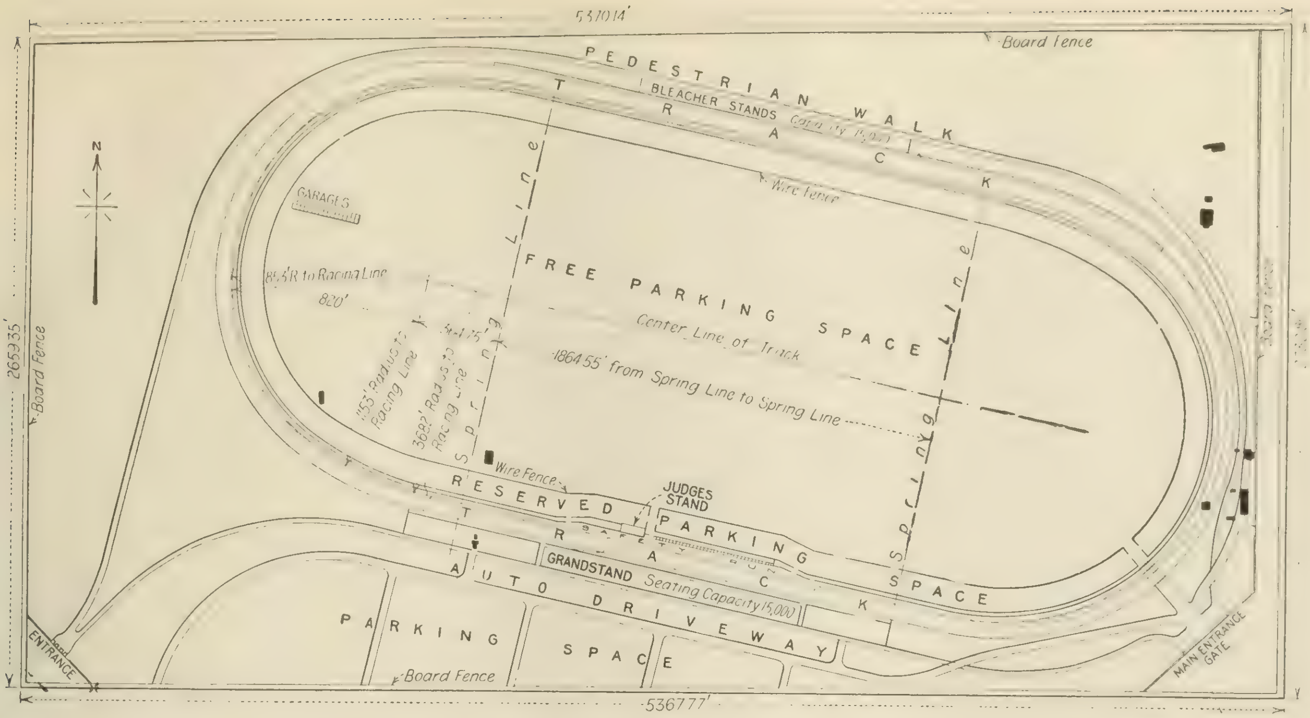


FIG. 2. PLAN OF CINCINNATI MOTOR RACETRACK, SHOWING ELEMENTS OF ALIGNMENT

the park, with some interior fencing and small structures, and an equal amount of lumber was required for the track itself.

Work was begun May 1 and was completed Aug. 31 of last year. The total cost, including land, was $550,000. The track was opened on Sept. 4 with a 300-mi. race. There were about 30 contestants, and an average speed of 97 mi. per hr. was made.

The architect was Harry Hake, of Cincinnati, and the contractors were A. Ryan & Co., of Springfield, Ill.

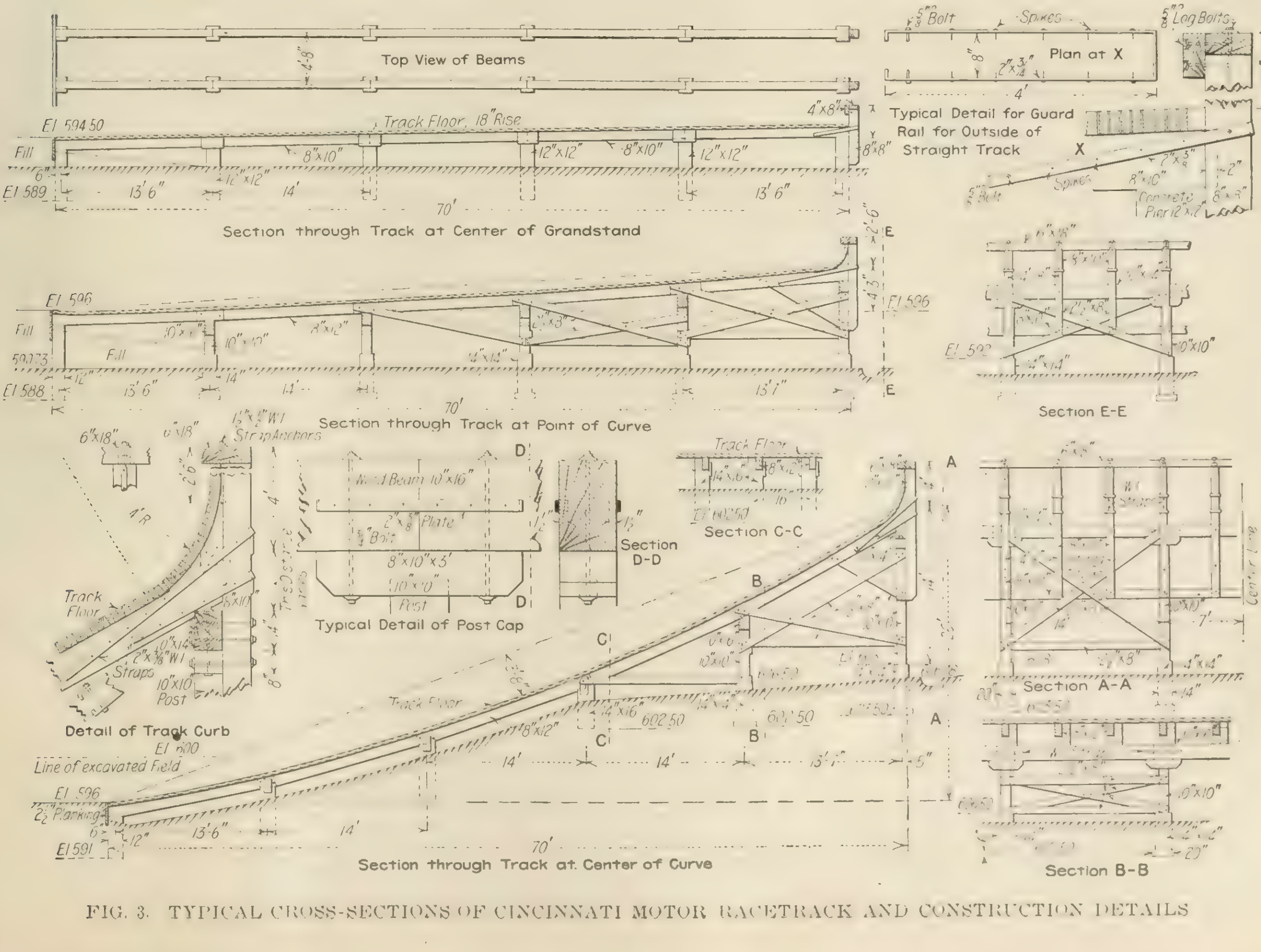


FIG. 3. TYPICAL CROSS-SECTIONS OF CINCINNATI MOTOR RACETRACK AND CONSTRUCTION DETAILS

Formulas for the Three-Piece Frame and Eccentrically Loaded Columns

By Alfredo C. Janni*

There are two ways of finding formulas for the stresses in a rigid frame of four or three members—namely, by the law of virtual works and by the theory of the ellipse of elasticity. In the opinion of the writer the second way is by far the shorter and the more elegant. For the present purpose, however, only the resulting formulas will be given, without going into the method of derivation.

The reader who wishes to familiarize himself with the theory of the ellipse of elasticity is referred to "Reinforced-Concrete Construction," by Prof. G. A. Hool, Vol. III, Chap. VIII, in which is shown a purely graphical method of designing arches derived from this theory.

Fig. 1 represents a three-member frame comprising a girder supported at its ends A and B by posts CA and DB, the girder connections at A and B being rigid and the two posts rigidly fixed at their bases C and D. By the theory of the ellipse of elasticity, if G is the elastic weight of the whole system $CADB$, its value is given by

$$G = \frac{l}{EI} + 2\frac{h}{E_1 I_1} \qquad (1)$$

where

E = Modulus of elasticity of the material of the girder;

E_1 = Modulus of elasticity of the material of the columns;

I = Moment of inertia of the girder cross-section;

I_1 = Moment of inertia of the column cross-section.

If for simplicity we put

$$\beta = \frac{h}{l} \times \frac{EI}{E_1 I_1}$$

then the expression (1) may be written

$$G = \frac{l}{EI}(1 + 2\beta) \qquad (2)$$

The vertical distance of the elastic center from the line AB will be given by

$$d = \frac{2\frac{h}{E_1 I_1} \times \frac{h}{2}}{\frac{l}{EI} + 2\frac{h}{E_1 I_1}} = \frac{h\beta}{1 + 2\beta} \qquad (3)$$

Since $\frac{l}{EI}$ is the elastic weight of the girder AB and $\frac{h}{E_1 I_1}$ is the elastic weight of one column, the moments of inertia of the entire elastic system with respect to the axes X and Y passing through the center of gravity of the elastic system will be given by

$$I_x = 2\tfrac{1}{3} \times \frac{h^3}{E_1 I_1} - Gd^2 = 2\tfrac{1}{3} \times \frac{h^3}{E_1 I_1} - \frac{l}{EI}(1 + 2\beta)d^2 \qquad (4)$$

$$I_y = \frac{l^3}{12EI} + 2\frac{h}{E_1 I_1} \times \frac{l^2}{4} \qquad (5)$$

The values (2), (3), (4) and (5) are the base upon which formulas for various cases of loading can be worked out, as will be shown presently.

Case 1. Concentrated Load—If we imagine that the end C is free, the elastic displacement of C under action of the load F, Fig. 2, may be considered as composed of a rotation and vertical and horizontal displacements. If, furthermore, we imagine that the elastic center G is rigidly connected with C, then its displacement will be the same as that of C; that is, it will have the same rotation and the same linear displacements, vertical and horizontal.

In order to bring G to its former position, we must apply at C a force capable of impressing upon G a rotation, a vertical displacement and a horizontal one equal and of contrary sign to those performed by G under the action of force F. This force (or group of forces) is the actual reaction at C.

Calling M, V and H the moment (with respect to center G), vertical component and horizontal component of this reaction, by the theory of the ellipse of elasticity we may write

$$MG = F\left(\frac{h}{E_1 I_1}d_2 + \frac{d_2}{EI} \times \frac{d_2}{2}\right) \qquad (6)$$

$$VI_y = F\left[\frac{h}{E_1 I_1} \times \frac{l}{2}d_2 + \frac{d_2}{EI} \times \frac{d_2}{2}\left(\frac{l}{2} - \frac{1}{3}d_2\right)\right] \qquad (7)$$

$$HI_x = F\left[\frac{h}{E_1 I_1}d_2\left(\frac{h}{2} - d\right) + \frac{d_2}{EI}d\frac{d_2}{2}\right] \qquad (8)$$

where the first members represent the rotation, the vertical displacement and the horizontal displacement of the point G under the action of the reaction R, while the second members represent the same displacements of G under the action, however, of the force F.

Formulas (6), (7) and (8), with the values given by formulas (2), (4) and (5), will become

$$M = F\frac{d_2}{2}\,\frac{\frac{d_2}{l} + 2\beta}{1 + 2\beta} \qquad (9)$$

$$V = F\frac{d_2}{l} \times \frac{6\beta + 3\frac{d_2}{l} - 2\left(\frac{d_2}{l}\right)^2}{1 + 6\beta} \qquad (10)$$

$$H = \frac{3}{2}F\frac{d_1 \times d_2}{lh(\beta + 2)} \qquad (11)$$

Incidentally it is seen by inspection of formula (11) that the horizontal thrust H varies according to the ordinates of a parabola.

Assuming that AB is a 20-ft. beam loaded with 2000 lb. at F, Fig. 2; h = 15 ft., d_2 = 12 ft. And assuming, for the sake of simplicity, that $\beta = \frac{h}{l} \times \frac{EI}{E_1 I_1} = \frac{15}{20}$, that is $E_1 = E$, and $I_1 = I$, we will have M = 10,080 ft.-lb., V = 12,120 lb., H = 349 lb. Therefore, the coördinates of the reaction R will be given by $x = \frac{M}{V} = 0.83$ ft., $y = \frac{M}{H} = 28.84$ ft.

Once the reaction is known, the stresses in any section of the column can be easily computed.

The position and intensity of the left reaction R being determined, it is an easy matter to determine the right reaction, remembering that the acting external force and the two reactions, must meet at the same point. This remark, of course, holds good for each of the following cases also.

Case 2. Uniform Load—If we call w the uniformly distributed load on the girder, then from formulas (9), (10) and (11), after simplifications, we obtain

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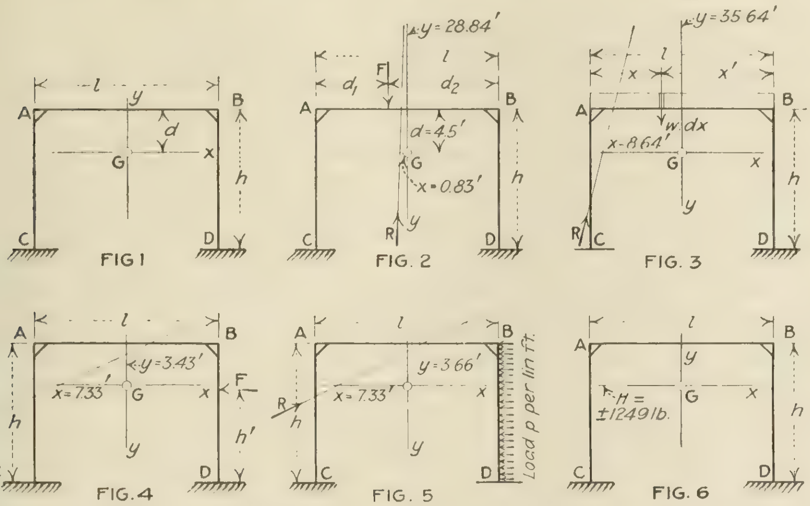
$$M = \frac{wl^2}{2} \times \frac{\frac{1}{3} + \beta}{1 + 2\beta} \qquad (12)$$

$$V = \frac{wl}{2} \qquad (13)$$

$$H = \frac{1}{4} \times \frac{wl^2}{h(2 + \beta)} \qquad (14)$$

For the same dimensions as in the preceding case, and again making $E_1 = E$, $I_1 = I$, the reactions for a load $w = 2000$ lb. per lin.ft. will be $M = 172{,}800$ ft.-lb., $V = 20{,}000$ lb., $H = 1818$ lb. Therefore the coördinates of the reaction R, with respect to the axes Gx and Gy, will be $x = 8.64$ ft., $y = 35.64$ ft.



STRESSES IN THREE-MEMBER FRAMES

Case 3. Horizontal Load—By considerations similar to those made in Case 1 and observing that, if the end C (Fig. 4) be assumed as free, its displacement is the result of the deformation of the system from D to F, since the force F has influence only on this part of the system, we obtain

$$MG = F\frac{h'^2}{2E_1I_1} \qquad (15)$$

$$VI_y = F\frac{h'}{E_1I_1} \times \frac{l}{2} \times \frac{h'}{2} \qquad (16)$$

$$HI_x = F\frac{h'}{E_1I_1} \times \frac{h'}{2}\left(h - d - \tfrac{1}{3}h'\right) \qquad (17)$$

Substituting for G, I_y and I_x their values given by (2), (4) and (5), we have

$$M = \frac{F}{2} \times \frac{h'^2}{h} \times \frac{\beta}{1 + 2\beta} \qquad (18)$$

$$V = 3F\frac{h'^2}{hl} \times \frac{\beta}{1 + 6\beta} \qquad (19)$$

$$H = \frac{3}{2}F\left(\frac{h'}{h}\right)^2 \frac{1 + \beta - \frac{1}{3}(1 + 2\beta)\frac{h'}{h}}{2 + \beta} \qquad (20)$$

With the same dimensions as before, and putting $F = 5000$ lb. and $h' = 10$ ft., the formulas give $M = 5000$ ft.-lb., $V = 681.8$ lb., $H = 1151.5$ lb. Therefore we derive $x = 7.33$ ft., $y = 3.43$ ft.

Case 4. Uniform Horizontal Load—Fig. 5 sketches the conditions. The following formulas may be derived from those for Case 3:

$$M = \frac{\beta p h^2}{6(1 + 2\beta)} \qquad (21)$$

$$V = \frac{\beta p h^2}{l(1 + 6\beta)} \qquad (22)$$

$$H = \frac{ph}{8} \times \frac{2\beta + 3}{\beta + 2} \qquad (23)$$

With the same dimensions as before, and with load $p = 1000$ lb. per lin.ft., these formulas give $M = 1125$ ft.-lb., $V = 153.4$ lb., $H = 306.8$ lb. The coördinates of the reaction R will be $x = 7.33$ ft., $y = 3.66$ ft.

Case 5. Variation of Temperature—If we still imagine that the end C of the elastic system is free to displace and that the temperature of the whole system changes t degrees, the shape of the system remains similar to its original shape, but a unit length will become $1 + at$, where a is the coefficient of linear expansion of the material. (Fig. 6).

The beam AB, will assume the length $l\ (1 + at)$, and the end A of it will displace itself in the direction BA of the amount lat, without rotating. The reaction R, acting on A, in order to push back A to its former place must pass through the elastic center G and must be horizontal. Therefore we may write

$$HI_x = atl \qquad (24)$$

which with (4) becomes

$$H = \frac{3EIat(1 + 2\beta)}{h^2\beta(\beta + 2)} \qquad (25)$$

Assuming $t = 40°$ F. as the change of temperature in the whole system, and $I_1 = I = 1$, $a = 0.0000067$, we have $H = \pm 1249$ lb.

In a similar way formulas for other assumptions of loading could be worked out.

Test Piles for Foundations—Preliminary to the design of the foundation of the new packing plant for Armour & Co., at South St. Paul, Minn., test piles were driven to determine the character of the soil and the pile-driving conditions, etc. Wood and concrete piles of different lengths were included. These were not for loading tests, and none of the piles were loaded. It was understood from the local authorities that rock would be struck at a depth of 24 to 28 ft., and a number of piles were driven at different parts of the site for the purpose of ascertaining ground resistance under the hammer, and also to see whether rock could be found. Although piles were driven to a depth of 60 ft., they did not reach any rock; hence the only result obtained from this test was that it indicated the resistance under the hammer. It was found that at a depth of about 20 ft. the penetration was about ½ in. per blow from a 5,300-lb. steam hammer of 30-in. stroke. At 26 ft. it seemed to run pretty regular in all piles, the penetration amounting to about ¼ in. and diminishing to about ⅛ in. at the last blow. It developed that with a wood pile driven down 50 ft. about the same penetration per blow was obtained as with a concrete pile at 26 ft. In view of these conditions it was decided to use wood piles. In determining the foundation piling for the proposed plant, the designers will take into consideration the ground resistance shown under the hammer and the desired load limit. The test piles were driven by Grant Smith & Co., of St. Paul, under the direction of R. C. Clark, of Chicago, architect for Armour & Co.

Slide Gates and Needle Valves in the Elephant Butte Dam

By F. Teichman*

In *Engineering News*, Nov. 30, 1916, p. 1015, the writer described in a general way the outlet control system of Elephant Butte Dam; below is given a short description of the two styles of gates employed in that control, the rectangular slide gates (3 ft. 11 in. by 5 ft. and 3 ft. 11 in. by 7 ft. 6 in.) and the balanced needle valves for 5-ft. diameter pipe.

Fig. 1 shows the 3-ft. 11-in. by 5-ft. slide gates. The upstream edges of the ribs of the gate leaf are connected by a faceplate, thus precluding the possibility of any drift being caught between the ribs and the roof casting. This faceplate has open cored holes (1⅝ in.) which in the process of molding were required to support the cores between ribs. The spaces that were occupied by the cores, at the lower end of the gate, are filled with concrete or hard-grade asphalt, which will prevent deterioration of the inner surfaces and adds mass to the gate. On account of this filling and of the use of both downstream and upstream faceplates on the gate leaf the tendency of the rod of the hydraulic cylinder. This arrangement of double through gate stems, compared with the usual central gate stem of partial penetration of gate leaf, has several advantages: It is easy thus to avoid a weakening of the gate leaf in the plane of the gate stems without increase of maximum thickness of gate body; any tension in the downstream faceplate of the gate (in the plane of the upper face of the nut of the central gate stem), which may be dangerous when opening a large gate, closed and under high head, is avoided; the axis of the piston rod is nearer the plane of the faceplate than is possible for a single gate-stem arrangement.

The gate leaf and the frame have bronze liners on three sides, the compositions being respectively: Copper, 82.7; tin, 7.1; zinc, 5.3; lead, 4.9; and copper 82.8; tin, 4.8; zinc, 4.4; lead, 8. These alloys originated with the James Jones Co. Brass Works, of Los Angeles. They are dense and hard castings that will slide on each other under heavy unit load without seizing. These liners are held in place by ½-in. rivets of Delta metal, heads being formed hot. This metal gave more assurance against a breaking under the head than any other bronze that was tried.

The crosshead of the gate stems and piston rod, which is cast in manganese bronze and has slight clearance be-

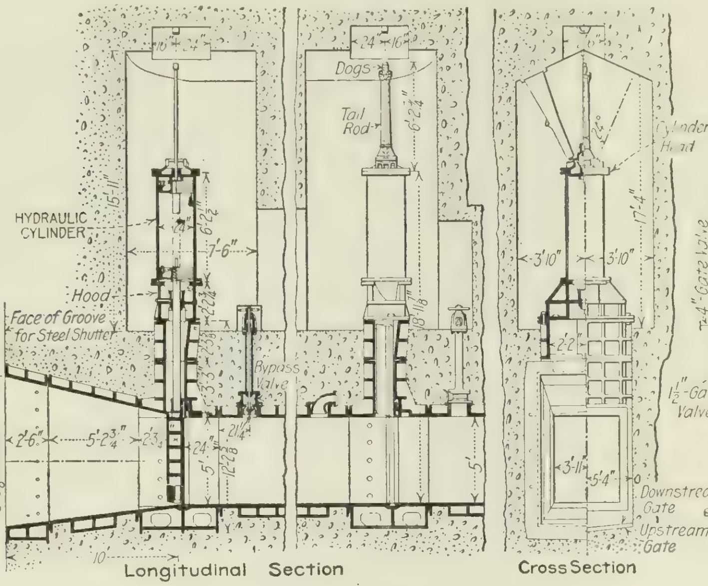


FIG. 1. THE ELEPHANT BUTTE DAM SLIDE GATES

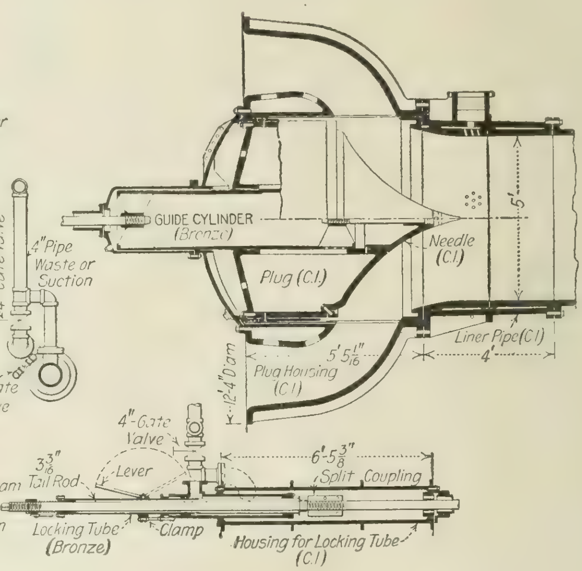


FIG. 2. THE ELEPHANT BUTTE DAM NEEDLE VALVES

lower end of the gate to objectionable elastic vibrations, while the gate is partly open, is greatly diminished. The gate is laid out with small clearance, ⅛ in. for the upstream plate and $\frac{1}{16}$-in. clearance in the guide grooves.

Details of the Slide Gates

The lower end of the gate makes closure not by overlapping the frame, but by contact of the finished end face of the gate leaf with a bar of babbitt cast and hammered into a taper groove of the floor casting and finished to a true face. Such a form of "end closure" has been used with success heretofore by the Reclamation Service for large gates under high heads.

The gate leaf is cored for its whole length for two gate stems, 15 in. c. to c., which connect at their upper end with a crosshead, threaded for the central piston tween the nuts of the gate stems and the gate leaf, has slightly more clearance around the gate stems than the gate leaf has in its guides, so that the gate leaf may move as far as the clearance in the guide grooves will permit without exerting any side pressure on the piston rod.

The side guides and the liner above the gate opening are so arranged that they can be taken out and replaced if, during the long life that is expected of the structure as a whole, they should deteriorate to an extent to make such replacing necessary.

There is only a single stuffing-box arranged between the hydraulic cylinder and the space wherein the gate leaf moves, and this stuffing-box can receive attention only after first raising the hydraulic cylinder. This may appear as an objection, but after the following description this objection will lose significance. Speaking, as an illustration, of the six penstock gates (3 ft. 11 in. by 5 ft.), which will always be either wide open or fully

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closed, their piping will be so arranged that they may individually be closed from the power house or any convenient place by simply turning a cock—a desirable convenience in case of accident to any machinery in the power house. This is accomplished by leading an individual pressure pipe from the power house to each hydraulic cylinder, with branches to both ends of the cylinder.

The discharge pipes from both ends of the cylinder lead into the gate housing—that is, to the reservoir water upstream from tthe gate. When the gate is open, the weight of the gate, etc., rests on two dogs fitted against the lower face of a collar screwed to the upper end of the tail rod. The dogs are connected by toothed quadrants and weighted. When the above-mentioned cock is opened, the pressure water enters under the piston and raises it about ⅜ in. (to the end of its stroke), the dogs are freed by the raising of the collar, they drop over and reverse the valves (or fourway cock) of the hydraulic cylinder, and the gate moves down to closure.

It will be seen that with closed cock and gate, either up or down, there is no leakage around the stuffing-box or the piston, the pressure everywhere being that of the reservoir. Under these conditions, where the stuffing-box is "working" only during the short periods when the gate is being raised or lowered, no deterioration of the packing of the stuffing-box need be anticipated, and it will be many years before it will become necessary to raise the cylinder in order to make the stuffing-box accessible. In the meantime the stuffing-box, being hidden, cannot occasion annoyance.

In all upstream gates the process of packing the stuffing-box is facilitated by a relief port and plug at half-height of the liner just below the stuffing-box.

By having the reservoir pressure as back pressure the working pressure must be so much greater. But at those times when the greatest effective pressure on the piston is required (when starting to open the closed gate) the back pressure may be reduced to atmospheric pressure.

To reduce as much as possible all danger of breakage of parts, cast-iron roof struts are provided with removable steel bar of slight taper, fitting between the lower end of the strut and a groove in the cylinder head. The structure is designed to be strong enough under maximum load (when the gate is being closed under maximum head) without the aid of the roof struts. But the device is simple and cheap and will gain in appreciation as the deterioration of the parts progresses.

Details of Balanced Needle Valve

The balanced needle valve is shown in Fig. 2. The body of the needle has at its upstream end an enlargement—the bullring—which works with slight clearance in the cylinder that surrounds it. The moving needle is subjected in any position to the following axial forces: (1) Gravity, if the axis of the needle is inclined; (2) friction; (3) pressure of the water in the chamber upstream of the needle; (4) pressure on the downstream face of the bullring; (5) pressure of reaction on the downstream face of the needle; (6) negative pressure on the downstream face of the jet, obtaining when the jet produces a partial vacuum in the space just below the needle. Force (3) is downstream, but will be upstream when suction obtains in the chamber. Force (5) is absent when the needle is closed.

The chamber has an outlet that controls the movement of the needle. With the outlet closed the needle will close by the action of the water that enters the chamber as leakage around the bullring. With the outlet sufficiently open the needle will open, the forces (4) and (5) predominating. For any given reservoir head and position of needle, there is a certain opening of outlet for which the needle will be held stationary in its position. With the needle closed and the chamber outlet closed there is no leakage around the bullring; likewise with the needle wide open and the outlet open there is no leakage, due to the bullring being up against an annular seat face inside the head of the chamber. For low reservoir head and closed gate (where force (4) is small and force (5) is absent), likewise for low reservoir head and small needle openings (where force (5) is small), especially if the axis of the needle is inclined—that is, force (1) is directed downstream—it will require a suction head in the chamber to open the gate or to hold it in open position—unless the bullring should have been made of large radial width.

In the accompanying figure the water leaving the chamber first enters the needle casting, then passes through the guide cylinder and the sleeve into the housing of the locking tube; then it passes out through the 4-in. gate valve, if this is open; or if this is not open and the locking disk stands at a distance from the end of the locking tube, it passes out through the locking tube and 3½-in. piping. The 4-in. piping can at will be connected to a draft tube. Ordinarily, the locking tube is pressed against the locking disk by the action of a spring at the end of the tail rod. If for any position of needle the locking tube is clamped by the mechanism provided therefor, and if the 4-in. gate valve is closed, the needle together with the locking disk will move downstream by the action of the leakage water passing the bullring until the distance between the end of the locking tube and the locking disk (less than one inch) is such that the resulting pressure on the upstream face of the needle balances all other axial forces on the needle, and there the needle will remain.

How To Operate the Needle Valve

These, then, are the simple rules for the operation of the needle valve: For opening the needle valve, open the 4-in. gate valve; for closing the needle valve, close the 4-in. gate valve; for holding the needle valve in any desired position, clamp the locking tube when the needle valve has attained that position. The rate of closing the needle depends on the rate of leakage around the bullring, and this may be smaller than is desired. For such case a 1½-in. bypass pipe is provided.

As the leakage water passes the bullring and enters the chamber of low pressure, air and carbon dioxide are liberated and will collect in the upper part of the chamber. These gases can easily be eliminated if the water in the chamber is under pressure, but not so easily if the chamber has the negative pressure of partial vacuum. Their presence—and therefore the partial vacuum—is objectionable because under such circumstances the needle may perform its opening or closing motion not evenly, but spasmodically, and such spasmodic motion may be harmful if occurring at either end of the stroke of the needle. It will be noticed that no damage can be done to the locking mechanism; the locking tube will merely slip

in the clamp in case of a lunging of the needle. No harm due to the lunging of the needle has yet been suffered by any of the needle valves of the Reclamation Service.

The Elephant Butte needle valve is a modification of the Ensign needle valve first designed by O. H. Ensign, of Los Angeles, for the Roosevelt Dam. That valve differs from the one here described in the following particulars: It has no tail rod; it has two V-shaped guides (instead of the six flat guides); it has a larger bullring (however, it still makes use of the vacuum), and the mechanism of control is different. It uses—in the later designs—the same principle of control tube (first suggested by the writer), but the control tube is not central and is moved upstream or downstream—the needle following—by means of screw and gearing.

The water for the operation of the hydraulic cylinders of the slide gates is furnished by a triplex 3x8-in. single-acting plunger pump driven by motor and installed in the small hydro-electric plant located at the toe of the dam. This pump can furnish 30 gal. per min. at 1000 lb. per sq.in. This is equivalent to a travel of the piston of 15 in. per min. in a 24-in. diameter hydraulic cylinder. Relief valves are arranged by which the maximum pressure can be defined. Single straightway valves regulate the inlet and outlet of the cylinders.

All operating galleries and chambers are well lighted and ventilated.

The different gate devices herewith described were designed by the writer and installed by E. H. Baldwin, Construction Engineer, and his successor, L. J. Charles.

The sluice and penstock gates (790,000 lb.) were furnished by the Hinman Hydraulic Manufacturing Co. (now the Vulcan Iron Works), of Denver, Colo. The machine work was excellent and the quality of castings good. The transition castings of the six penstock conduits (rectangular section of conduit going over into round section), followed by 10 ft. of straight 5-ft. diameter pipe (total 222,600 lb.) were furnished by the Eddy Foundry Co., of Milwaukee, Wis. The 3-ft. 11-in. by 7-ft. 6-in. slide gates (422,000 lb.) were furnished by the Coffin Valve Co., of Neponset, Mass. The machine work was of a high order. The four balanced valves (364,000 lb.) were furnished by the Best Manufacturing Co. (now Kennedy-Stroh Corporation), of Pittsburgh, Penn. The machine work and the quality of the castings were very satisfactory. The cost of all this machinery was about \$147,000. The total cost of the gates in place, with all auxiliaries, is approximately \$221,000.

Design and Construction of Double Sewer at Jamestown, N. D.

Changes and extensions of the sewerage system of Jamestown, N. D., have required the construction of about 8000 ft. of double sewer, designed to provide for the complete separation of sewage and storm water. The sewage is carried in a vitrified pipe placed in the bottom of the trench, and the storm water in a separate horseshoe-shaped monolithic concrete section placed directly above the sanitary section, as shown in Fig. 1.

FIG. 5. VIEW OF EXCAVATOR AT WORK ON DOUBLE SEWER AT JAMESTOWN, N. Y.

Alternate bids were received for double sewers, using the type of construction shown in Fig. 2, the storm-water section to consist either of segmental sewer blocks or of reinforced-concrete pipe supported on a lean concrete saddle. The lowest bid for the type of construction shown in Fig. 2, based on segmental sewer blocks, was \$4200 above the contract price for the type of construction shown in Fig. 1, and the lowest bid based on using reinforced-concrete pipe was \$10,000 above.

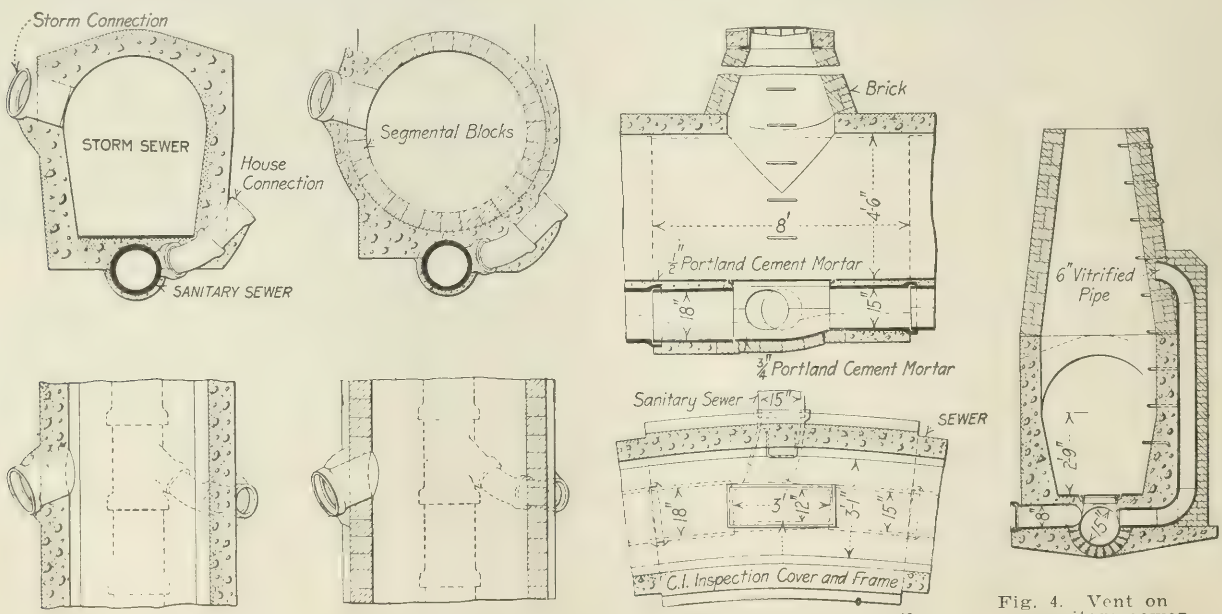


Fig. 1. Adopted section Fig. 2. Alternate section Fig. 3. Manhole details Fig. 4. Vent on sanitary sewer

FIGS. 1 TO 4. DETAILS OF STORM AND SANITARY SEWERS, JAMESTOWN, N. D.

The size of the sanitary section will vary from 12 to 18 in. in diameter and the size of the storm-water section from 32x41 in. (equivalent to 36 in. circular) to 44x54 in. (equivalent to 48 in. circular).

The type of construction shown in Fig 1 will be used throughout, with the exception of a short distance near the outlet, where the storm-water section will be carried direct to the river and the sanitary section will be carried a few hundred feet to the east to the site of the sewage-treatment plant. Fig. 1 also shows the manner in which the house connections will be made to the sanitary section and the storm-water connections to the storm-water section.

Manholes of special design will be used, as shown by Figs. 3 and 4, Fig. 3 being the manhole where a 15-in. intercepting sewer connects to the trunk sewer and Fig. 4 showing how the connection between different sizes is made. Vents, as shown in Fig. 4, will be provided at a number of manholes along the line of the sewer to furnish ventilation for the sanitary section until such time as a sufficient number of house connections have been made.

At each manhole and at several points between manholes, where the manholes are at some distance apart, inspection covers and frames will be provided at the bottom of the storm-water section for the purpose of giving access to the sanitary section for inspection and cleaning.

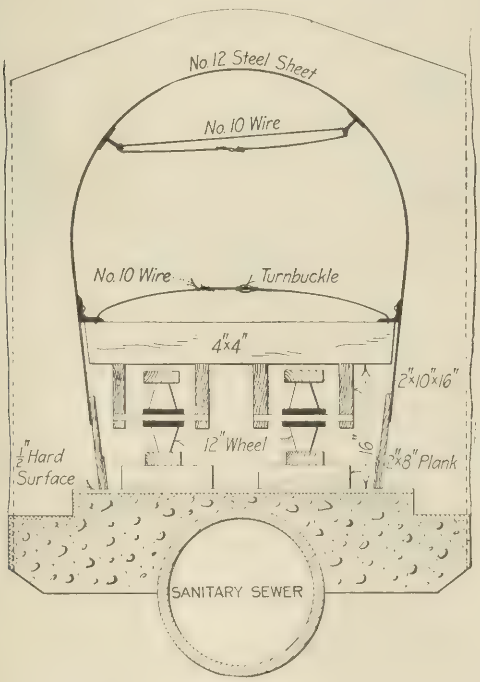


FIG. 6. FORM USED FOR JAMESTOWN DOUBLE SEWER

The trenching is done with a W. G. Humphrey excavator (Fig. 5). The material is shale with some sand and gravel. As the trench is cut with the machine, the base for the vitrified pipe is shaped and the material cast into the excavator by hand. The pipe is then laid and backfilled to the half-section, and the concrete base is poured and finished with a ½-in. hard surface. From 170 to 240 ft. of pipe and base is put in each day.

The forms used for the side walls and arch consist of No. 12 sheet steel, in 60x120-in. sheets, bent to correct lines and held to form by wiring (Fig. 6), fastened to small tee and angle irons riveted to the inside of the sheets. The forms are supported by 4x4-in. timbers, spaced 4 ft. apart under the lower angle irons and carried on the frames of a series of four-wheeled cars. The trains are made up of two strings, one 120 ft. long and one 130 ft. long, a train of forms being removed each alternate day. The forms are brought to position by wedges and shims between the car frame and the concrete base, the entire weight thus being taken off the car wheels. A 10-in. board is used on each side to complete the form for the side wall and allow for raising and lowering.

The concrete mixer works on the surface, the concrete being distributed in two-wheeled carts and carried into the trench for both base and side walls by means of troughs.

The double sewer is about completed and the construction of treatment works started. These will include an Imhoff tank of reinforced concrete, with 2½-in. rib-lath plastered curtain walls, work on which will be begun in February, sludge-drying beds, and a short outlet from the tank to the James River. The double sewer and treatment works were designed by L. P. Wolff, consulting engineer, St. Paul, Minn., and are being carried out in direct charge of J. M. Hansen, city engineer. The contractor is William Danforth, St. Paul, Minn.

War Department Forming Engineer Enlisted Reserve Corps

The members of the Engineer Officers Reserve Corps, United States Army, have been notified by the War Department that a large enrollment is desired of enlisted men in the Engineer Enlisted Reserve Corps, provided for in the National Defense Act of June 3, 1916. All the equipment, subsistence and transportation are furnished by the Government, during service. An annual training period of 15 days is required. Pay ranges from $75 to $15 per month. The following requirements are stated for the several grades in the pioneer regiments:

Master Engineer, Senior Grade—Required at times to take the place of officers and to take independent charge of construction in the field; must be specially qualified also as expert lithographer, photographer, draftsman, surveyor or construction superintendent. Two to each regiment.

Master Engineer, Junior Grade—Same qualifications as for master engineer, senior grade; must be specially qualified as foreman electrician and expert searchlight operator, foreman carpenter, construction foreman or foreman machinist and engineman. Three to each battalion.

Other Grades Above Sergeant—Grades include sergeant major, sergeant first class, and supply, color, bugler, first and stable sergeants. Same qualifications required as for sergeant; must be specially qualified as master carpenter, master mechanic, road foreman, expert in demolitions, blacksmith, rigger, boatman, topographer or draftsman. Seven per company.

Sergeant and Lower Grades—Qualifications ascertained by recruiting or recommending officer. Every enlisted man out of the 109 in a pioneer company must have some special qualification, distributed (two to four each) among the occupations already noted and also among quarrymen, miners, plumbers, firemen, masons, calkers, axmen, packers, teamsters, saddlers, cooks, clerks, musicians and signalmen, the greatest preponderance being of topographical surveyors and sketchers (9), quarrymen and miners (11), bridge carpenters (16), electricians (6), axmen (8), teamsters (10). Six sergeants and 12 corporals per company.

Metering Fire-Protection Sprinkler Systems at Pittsburgh, Penn., will not be required, the council having passed over the veto of Mayor Joseph G. Armstrong an ordinance designed to relieve owners of such systems from setting meters.

Makawao Water-Works for Rural Supply

By Joel B. Cox*

SYNOPSIS—County water-supply for rural district, maintained under tropical conditions.

The Makawao water-works, in the County of Maui, Hawaii, are unusual in two respects—the very scattered consumers with comparatively great length of distributing mains, and the extreme difference of elevation (4200 ft.) between intake and lowest consumer. The maintenance problems of a wood-stave pipe in a tropical jungle are also of interest. The works were built with territorial funds under territorial supervision, but are operated by the county.

The water-works are situated on the slopes of Haleakala, an extinct volcano with a height of 10,032 ft. They supply water to 35 sq.mi. of farming and stock country, where without it there could be no settlement, as the rainfall is too infrequent and uncertain to provide drinking water, and there are no underground or surface supplies.

The highest intake is in Puohakamoa gulch, which contains a small but very constant stream, deep in the jungle on the eroded northeast slope of the mountain. This water is carried to Waiakamoe gulch, a distance of 1.5 mi. Waiakamoe is larger, but is not so steady a stream. In extremely dry periods it falls to a mere trickle. Here is a small reservoir behind a timber overfall dam. There are many smaller intakes in the intermediate gulches. The water is highly colored and has a characteristic taste of wood and other vegetable matter, as is the case with nearly all the jungle streams, but is otherwise of excellent quality.

From Waiakamoe a 12-in. wood-stave pipe 3.61 mi long worms its way out of the forest to the open lands at Olinda, where the storage reservoir of the line is now being built. Here the largest branch leaves the main line and plunges straight down the mountain to Makawao and Paia, a 4100-ft. fall in 12.28 mi. The main line continues over a rapidly drying but very fertile slope, unwooded but seamed by sudden deep gulches, to the picturesque hills of the southwest corner of the island. The grade is from 1.5 to 3%.

Beyond the tenth mile from Olinda the country is used as a stock range, and the water is carried to the watering troughs of the stock ranches. Even beyond the end of the county line at Auahi, which is 22.4 mi. from the waterhead, a stock ranch takes the water some 1 mi. farther through its ranges.

The profile (Fig. 1) shows the relative elevations of the various parts of the system, but it is on too small a scale to show details of the topography. The country to the east of Olinda is very steep and rugged, consisting of a succession of narrow and deep gulches hewn out of the lava rock and covered with a dense coat of moss, ferns, vines and trees, a thick jungle through which progress is almost impossible without a trail. The general slope of the country throughout the length of the line is about 700 ft. per mi., and at times of storm each gulch carries a torrent of great velocity and of a magnitude demanding careful consideration.

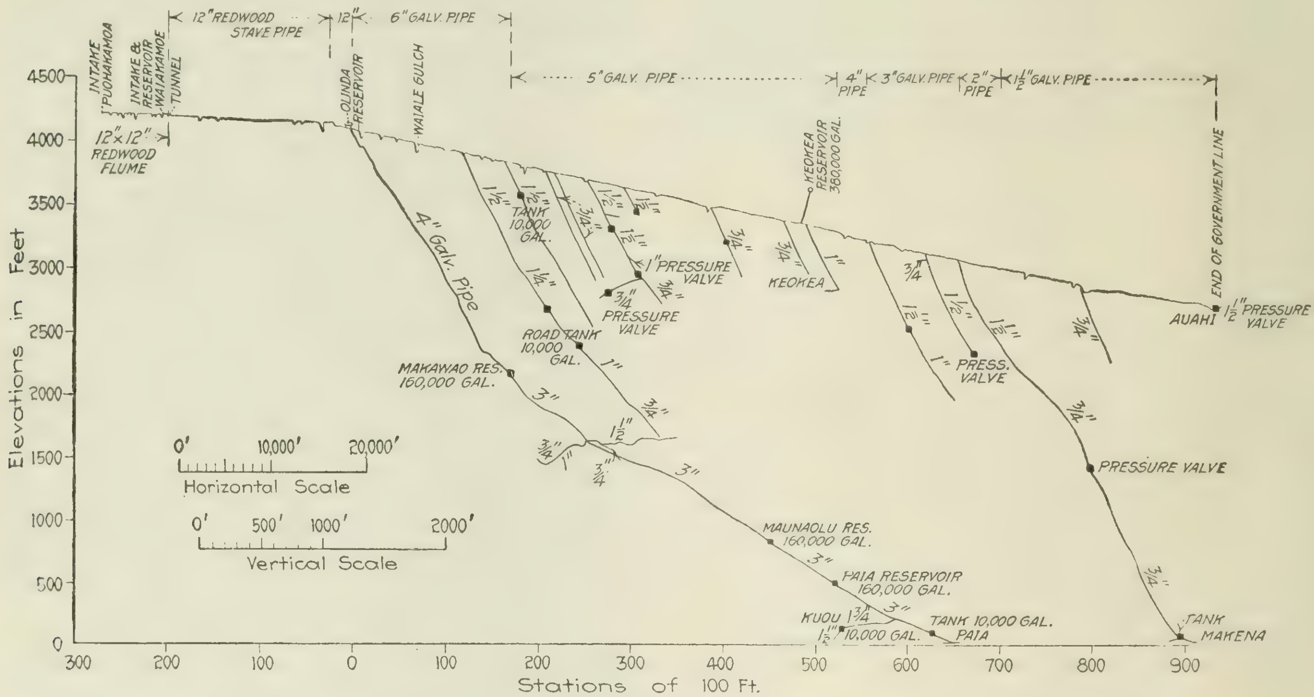


FIG. 1. CONDENSED PROFILE OF THE MAKAWAO WATER-WORKS, MAUI COUNTY, HAWAII

In the maintenance of the line above Olinda the extreme rate of growth of the tropical jungle and the equally surprising rate of decay of ordinary timber are the striking facts. As most of the gulches are crossed on timber trestles, the maintenance of these trestles is

*County Engineer, Maui County, Wailuku, Maui, Hawaii.

a large factor. The Oregon fir, or "Nor'west" lumber, that was first used began to fail in two years, and decay was practically complete after five. Even though carefully protected by surface treatments of hot tar, the decay is easily apparent in six months' time. No creosoted or other protected lumber is here available without excessive cost.

A trail open to horses and pack animals is maintained as far as Waiakamoe, but only by the utmost labor. The rich humus that overlies the lava rock, with the continual rainfall and constant warmth and moisture, promotes vegetable growth at a rate unheard of in harsher climates. If a banana tree is cut down in the morning, by night it has sent up a 3-in. sprout from the stump, while a month's nonuse of a trail renders it difficult to distinguish the path it followed, so thick is the new growth.

The normal rainfall is the effect of the constant northeast trades, and its rapid variation with distance around the mountain is remarkable. From Waiakamoe to Olinda, a distance of 3.5 mi., the annual rainfall drops from 319.7 to 69.1 in. The heavy rainfall of the collecting area for the water-works is very well distributed, as is shown by the accompanying table. The longest drought on record was of three months' duration, during which time only light showers fell at Waiakamoe.

The normal rainfall on the southwest and south slopes of the mountain is comparatively light and occurs in sudden showers caused by a backlash of the vapor-laden trade winds around the bulk of the mountain. In contrast to the trade-wind rains are southerly storms causing the floods of the southwest and west slopes. These storms, called "Konas," sweep the islands four or five times in three years. The intensity of rainfall at such times is very great, precipitations of 10 to 12 in. in 24 hr. being common. The highest intensity on record for the Island of Maui was 24.30 in. in 3 hr., which was carefully observed in April, 1915, at Hana. The rainfall in 24 hr. at the same time was 28.20 in. (United States Weather Bureau records).

MONTHLY RAINFALL IN INCHES, ISLAND OF MAUI, HAWAII

	Waiakamoe, 5 Yr.			Puohakamoa, 4 Yr.		
Month	Av.	Max.	Min.	Av.	Max.	Min.
January....	24.88	47.54	2.96	16.62	35.85	3.60
February...	33.48	76.15	13.03	23.97	46.32	10.60
March.....	18.44	31.02	7.98	30.89	53.52	8.44
April.......	34.39	53.35	22.68	37.22	47.80	20.89
May.......	29.34	87.58	6.29	27.00	84.61	5.92
June.......	21.84	39.74	9.25	22.09	39.59	12.48
July.......	16.42	24.65	10.72	18.45	32.50	7.78
August.....	17.21	22.30	12.52	17.96	29.43	11.40
September..	23.84	34.70	13.17	21.42	31.84	14.00
October....	17.46	32.17	6.40	20.60	32.42	8.79
November..	33.41	45.54	20.10	39.76	41.69	38.80
December..	36.73	80.02	16.09	13.56	16.14	11.02
Yearly av. max. and min.....	307.44	87.58	2.96	289.54	84.61	3.60
Long-time	319.7			303.5		

Flume, Reservoirs and Pipe Lines

The water from Puohakamoa is carried to Waiakamoe in a rectangular redwood flume. This flume is built of three 2x12-in. surfaced redwood planks; it is 10 in. deep and 12 in. wide, inside dimensions. It is covered with short pieces of the same planking.

The Waiakamoe dam has a height of 8 ft. It has a vertical upstream face of 2x12-in. plank, spiked to 6x8-in. studs 2 ft. c. to c. These studs are braced with 6x8-in. timbers at an angle of 45°, which form a log rollway in time of flood. The whole is placed on a concrete foundation at a narrow rock gap. Severe floods carrying many large logs have passed over this dam, and the only damage has been the occasional loss of a plank. The reservoir is of only 500,000 gal. capacity, the depth being limited by a porous stratum in the rock. It fills up badly with boulders and gravel at the time of flood, but is easily cleaned by sluicing and some handwork.

The line from Waiakamoe to Olinda is of 12-in. redwood-stave pipe. The short turns are made by special cast-iron elbows of various odd angles. These elbows are made with bells, into which the ends of the wood-stave pipe are leaded. The largest gulch is crossed by an

FIG. 2. WAIALE GULCH CROSSING, MAKAWAO WATER-WORKS
At this point the pipe line is of 6-in. galvanized iron

inverted siphon, but in most places the line is carried across on trestles and timber trusses. The original construction was of Nor'west, or Oregon fir, but this timber decayed entirely within five years, owing to the constant soaking. Since then the bridges have been replaced, using redwood, and the trestles have been rebuilt with a native hardwood, Ohia, cut alongside the line and prepared in the form of rough round poles, notched and spiked into place.

The main line is of galvanized-iron pipe of 6- to 1½-in. diameter. The laterals are of the same construction, using smaller pipe. The original laying was very hastily done, and the line was left entirely exposed to the air (Fig. 2). The result was excessive expansion and contraction, which tore the threads out of the sleeves. The line is now buried with about 6 in. of earth cover. Gulch crossings are either on masonry piers or underground.

The reservoirs on the Makawao branch are rectangular concrete structures of 160,000 gal. capacity, roofed and screened. Keokea reservoir is of masonry and is bowl-shaped, with a capacity of 380,000 gal. It has been lined with cement plaster and with asphalt to check an early excessive leakage.

The new Olinda reservoir now under construction will have a capacity of 6,450,000 gal. It is flatiron shaped and is placed in a small valley behind a rock-fill dam 38 ft. high. It is everywhere excavated to a very poor quality rock and will be lined with reinforced concrete. The flood waters of the little valley are diverted by a storm ditch. With a fall of 700 ft. to the mile, it will readily be seen that the country does not offer sites for large reservoirs.

Pressure Regulation Under Difficulties

As will be evident from an inspection of the profile, the matter of pressure regulation is of great importance and some difficulty. The Makawao-Paia line is broken by three reservoirs and one 10,000-gal. tank, the lower

three equipped with float valves. The maximum static head on the upper reservoir is 1910 ft., but no float valve is in use here.

The main line has a pressure break at the Keokea reservoir. Somewhat below this it is intended to install a 4-in. Golden-Anderson pressure-regulating valve. The laterals, which run directly down the mountainside, have pressure broken at approximately 600-ft. (vertical) intervals by tanks and float valves or by pressure-regulating valves.

The earlier meters used broke continually under service pressures, but under the present conditions the meters now installed are giving excellent service. Some silt and small débris occur in the water. They are difficult to remove at the intakes and have given trouble in the valves and meters, but more careful screening and the installation of fish traps are eliminating this difficulty.

Water-Supply and Consumption

Accurate records have not been kept long enough for definite figures, but the following are estimates based on present conditions and records:

	Gal.
Normal annual runoff of Puohakamoa and Waikamoe streams at 4,200-ft. elevation	500,000,000
Average consumption:	
Makawao branch, per day	150,000
Kula branch, per day	200,000
Total, per day	350,000
Total, per year	127,750,000

The total storage of the line after the completion of the Olinda reservoir will be about 7,800,000 gal.

Historical and Financial

The original construction of the line was in 1910-11, under territorial supervision and with a territorial appropriation. The Puohakamoa flume was built in 1912. From this time until January, 1916, the system was allowed to continue with no intelligent supervision or adequate maintenance. The result was a condition of chaos—an inadequate water-supply; trestles under the wood-stave pipe which threatened to fall at any moment and did fall with great frequency; a meter system of selling water in which barely 25% of the meters were registering; and a distributing system through which perhaps 33% of the water reached a consumer.

Since then new trestles have been built, the wood-stave pipe has been put in excellent condition, the main galvanized pipe has been buried, and the distributing system has been brought to fair shape. A universal meter system has been installed, giving excellent satisfaction to the consumers and to the water-works. The Olinda reservoir, which it is hoped will assure an adequate supply at all times, will soon be completed.

The water-works have been a heavy drain on the county from the time of their construction, but the installation of a meter system and careful supervision of accounts bid fair to allow the works to pay expenses and make a slight return on the investment. The rates are fixed by a county ordinance and are exceedingly low (15c. per 1000 gal.), considering the scattered consumption. The following are the principal items in the financial history and present status of the water-works:

Approximate first cost	$200,000
Approximate yearly cost of maintenance, 1913-15	9,000
Approximate yearly income, 1913-15	2,500
Cost of reconstruction, 1916	12,500
Present yearly income	7,387
Present cost of maintenance	7,648

The income is steadily increasing, and it is hoped that it may reach $10,000 a year without raising the rates.

Dry Reservoir for Flood Control on the Oder River in Germany

By Kenneth C. Grant*

The Buchwald reservoir is one of a group of 12 "dry" reservoirs, or retarding basins, built to control floods on tributaries of the Oder River in the Province of Silesia, in southeastern Prussia. It is located on the Bober River, near the headwaters, the drainage area above the dam being only about 23 sq.mi. The Bober empties into the Oder at Crossen.

The Buchwald dam, besides its interest as a work for flood control, is notable as being the first concrete dam built in Germany. It was constructed in 1903-05 by the Province of Silesia and the Prussian Government. It is 88 ft. high above the deepest part of the foundation, about half of this height being above the natural ground surface. The width on top is 10 ft., and the maximum bottom width is 57 ft. The crest of the dam is 750 ft. long and is arched upstream with a radius of 820 ft. The dam contains 36,200 cu.yd. of concrete.

The reservoir has a capacity of 77,660,000 cu. ft., all of which is kept empty and used solely for flood control. About 160 acres are flooded when the reservoir is filled to spillway level. This land is used for pasture and raising hay. It is rented for about $2.70 per acre per year. The average cost of the land was about $270 per acre.

At the left of the dam there is a concrete spillway 164 ft. long, with a freeboard of 6.6 ft. With a head of 2.6 ft. on the crest this spillway will discharge about 3180 sec.-ft. The crest of the spillway extends along the side of the valley upstream from the dam and delivers the water to a paved channel 33 ft. wide, passing through the dam and descending to the river channel below by a series of cascades paved with heavy rubble masonry. The channel of the Bober is paved for some distance below the lower end of the cascades. Near the left end of the dam, in the old Bober channel, there is a single outlet at the level of the stream bed, 41 ft. below the crest of the spillway. This outlet is elliptical in cross-section, with the longer axis horizontal, and has a cross-sectional area of about 27 sq.ft. With the reservoir full to a depth of 2.6 ft. on the spillway the outlet will discharge 1060 sec.-ft., so that, combined with the 3180 sec.-ft. that is then going over the spillway, the total outflow is 4240 sec.-ft., or 184 sec.-ft. per sq.mi., which was the maximum rate of discharge in the great flood of July, 1897. This outlet is lined with rubble masonry and is provided with a gate, to give better control of small floods. A channel paved with rubble masonry conducts the water from the outlet to the main channel, which it joins about 130 ft. below the dam.

There have been several floods of considerable size since the completion of the reservoir. The greatest of these was in July, 1907, when the reservoir was filled to within about 5.3 ft. of the spillway crest.

The concrete was mixed by machinery in the proportions of ½ part cement, ½ part trass, 4 parts sand and 8 parts crushed stone. The trass was added to the cement in order to give better resistance to the movements resulting from temperature changes, which it was considered would be particularly felt in this dam, by reason

*Assistant Engineer, Miami Conservancy District, Dayton, Ohio.

of the reservoir being empty the greater part of the year. In the outer surface of the dam a still smaller proportion of cement was used.

The stone, which was quarried at the site, consisted of conglomerate and graywacke. It was cleaned, washed and crushed, and then used in the concrete without screening, a sufficient amount of coarse, sharp quartz sand being added to obtain the above proportions. The tests of this concrete showed a compressive strength of about 1130 lb. per sq.in. after 28 days.

On the upstream face the dam is covered with a waterproofing compound. In most German dams this coating is protected by a layer of masonry about 3 ft. thick. In the Buchwald dam this masonry protection has not been provided, and the upper 23 ft. is exposed to the weather. An earthen fill on a 2 to 1 slope reaches to within 23 ft. of the top of the dam and protects the lower part of the waterproof coating. On the downstream face of the dam the concrete surface has been artificially roughened to improve its appearance. There has been some criticism of this treatment by German engineers, who have claimed that it has made the surface more porous and will permit rainwater to penetrate the concrete more readily and will increase the destructive action of frost.

BUCHWALD RETARDING BASIN FOR FLOOD CONTROL OF THE ODER RIVER IN PRUSSIA

The dam and appurtenances cost $204,000, and the land and damages cost $60,000, or a total of $264,000, or about $3400 per million cubic foot of storage. The Prussian Government paid 80% of the cost of the work. The Province of Silesia paid the other 20%.

The Buchwald reservoir is located about 35 mi. above the Mauer reservoir,[1] and its partial control of the 167 sq.mi. of drainage area above the Mauer dam is supplemented by five other retarding basins, built by the same authorities.

Concrete has been very little used in the construction of dams in Germany. The first German dam in which concrete was used in part as building material was the dam of the Solingen water and electric works, which is an earthen dam 43 ft. high, with a concrete core wall, built in 1901. It was at first proposed to build the core wall of rubble masonry, but the change to concrete was made because it enabled the more rapid completion of the dam. For the Urft dam, 196 ft. high, and the Nordhausen dam, 90 ft. high, both completed about 1904, the use of concrete in the body of the dam had at first been considered, partly because of the scarcity of suitable stone for rubble masonry and partly because of the greater speed that could be made if concrete were used. In both cases, however, it was finally decided to build the dams entirely of rubble masonry, owing to the considerably greater cost if concrete were used.

The arguments of the German engineers against the use of concrete in dams have been the high construction cost and doubts regarding the resistance of concrete to weathering. They have also felt that there is danger of the formation of cracks in exposed thin walls of concrete, due to the greater proportion of mortar than in rubble-masonry work. Their rubble-masonry work contains about 30 to 40% of mortar, while their concrete contains from 45 to 50%. The expansion coefficient of mortar is greater than that of stone, and German experiments on the movement of dams have determined that the expansion coefficient for rubble masonry is 0.0000078 for 1°, and for concrete is 0.00001228 for 1

[1]See "Engineering News," Apr. 3, 1913, p. 672

Report on Collapse of Falsework on Spokane Concrete Bridge

By John C. Ralston*

SYNOPSIS—The 250-ft. twin-rib reinforced-concrete arch bridge on the line of Post St., across the Spokane River at Spokane, Wash., collapsed during construction on Feb. 6. The following report gives the details of the falsework that failed.

The Post St. bridge, the collapse of which at 3:20 p.m., Feb. 6, 1917, caused the death of three workmen, was intended to be a reinforced-concrete arch, twin-rib, open-spandrel, highway city bridge. It is located in the heart of Spokane, Wash., spans the Spokane River midway of the two falls and was to have had a clear span of 250 ft. with a rise of 33 ft. The two arch ribs were 6x6 ft. at the crown and 6x8 ft. at the haunch, connected by seven diaphragms.

Its site lies midway between the Great Northern Ry. main-line double-track steel bridge on the north, distant about 50 ft., and the Washington Water Power Co. double-track steel bridge on the south, distant about 30 ft. A sheer escarpment of about 40 ft. of solid basaltic rock marks both banks of the river and thus constitutes an ideal site for the type of bridge contemplated. The bedrock presents nearly a level profile across the channel. River débris of small boulders, sand and gravel covers most of the bedrock to a depth of 4 to 6 ft., excepting at the west side of the channel, where the bedrock is exposed for a short distance, according to information given by the City Engineering Department.

The falsework for the bridge was designed by P. F. Kennedy, the engineer for Oleson & Johnson, the contractors. The erection of the falsework, together with the pouring of the ribs, was in direct charge of Mr. Kennedy until one week prior to the collapse, when Kennedy either fell or was knocked off the service bridge and was drowned. Thereafter the work was carried on under the direction of H. O. McCall, General Foreman, who no doubt followed the schedule of progress as laid out by the engineer. General supervision was under Morton Macartney, City Engineer, and his assistant, B. J. Garnett.

The falsework consisted of 18 bents spaced 12 ft. 4 in. c. to c., and each bent contained six carrying piles and one tie pile, capped with 12x12's, drift bolted with one ¾-in. round bolt per pile. False bolsters of 4x10 in., laid flat, over each pile, presumably continuous, constituted the longitudinal ties of all the bents at the top of the first story. This tie, however, seems to have been omitted between Bents 8 and 9 west, as shown by Fig. 4, although a partial substitute was put in in the form of a flat sway brace and spiked to the posts. This substitute seems to have been an unfortunate one. It is not apparent that the flat bolsters were drift bolted to each cap. On the contrary, it would appear from such meager evidence as now exists that the connections were made by toe-nailing with wire spikes these insufficient bolster members.

The accompanying elevation (Fig. 2), compiled on Feb. 8, 1917, by the city engineer's office from sketches in the contractors' office, snows that four lines of longitudinal sway bracing were carried from end to end. Existing evidence shows that this system of sways, with possibly two exceptions at the east end, was spiked to

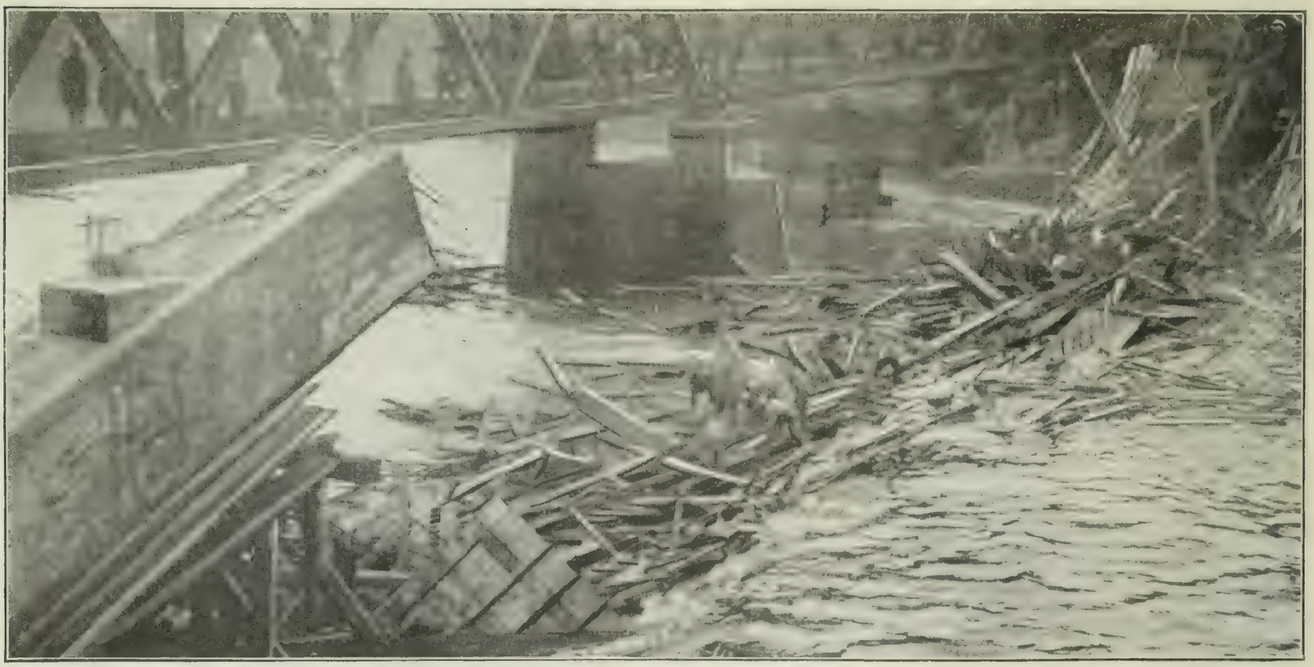


FIG. 1. VIEW OF POST ST. BRIDGE LOOKING WEST AFTER COLLAPSE
The projecting rib in the foreground fell some three hours after the initial collapse

*Consulting Engineer, Spokane, Wash.

the piles instead of being bolted. One workman stated that from one to three spikes were used. Fig. 3 shows that two or three spikes were used, but no bolts. None of the piles now standing nor any of those enmeshed in the débris that could be seen had been barked, so that clearly the sways were spiked through the bark, which generally is about 1 in. thick. This thickness, together with from 1 to 2 in. of soft sapwood, plus the thickness of the sway brace, gave a very insecure hold to an 8-in. spike and practically no holding value to a 6-in. spike, if such were employed.

A 3000-lb. hammer was used in driving the piles, and every pile is said to have been driven to refusal. General Foreman McCall and his workmen are clear on this point. The writer's long acquaintance with McCall justifies complete confidence in any statement he may make. The nature of the river bed is such that some piles might have come to refusal on boulders; and inasmuch as the depth of penetration at best was small, rigid horizontal and diagonal bracing would be necessary with a liberal use of through bolts and washers. It is reported by some of the workmen that, where known boulders were encountered, the piles in such cases were driven off center from a few inches to nearly 3 ft. in one instance.

The second story of the falsework (Fig. 3) was made up of 6x8-in. and 8x8-in. posts, built up of 4x8's, and in lengths from 4 ft. 8 in. to 22 ft. 11⅛ in., according to the schedule in the accompanying table. It does not appear how the two pieces making up the member were fastened, whether with spikes or bolts. The ordinary transverse sway bracing was used, according to the plan; but it is not shown whether it was bolted or spiked.

SCHEDULE OF SECOND-STORY POSTS

Mark	Number of Bents Required	Size of Posts * In.	Length of Posts Ft.	In.
Bent 1	2	6x8	22	11[illegible]
Bent 2	2	6x8	22	3[illegible]
Bent 3	2	6x8 or 8x8	21	1[illegible]
Bent 4	2	8x8	19	1[illegible]
Bent 5	2	8x8	16	6[illegible]
Bent 6	2	8x8	13	[illegible]
Bent 7	2	8x8	9	3[illegible]
Bent 8	2	8x8	4	8

* The 6x8-in. posts were made from 6x8-in. sticks, but the 8x8-in. posts were made up of two 4x8-in. sticks.

Longitudinal sway bracing seems to have been used on alternate panels only.

The joists, with one or two exceptions, were 3½x15-in. Douglas fir and, together with some of the other stuff, were salvage materials from the floor of the old steel bridge that the new structure was to replace. This material, however, was all sound and not much over a year old. All joist had butt joints and rested without dapping on beveled shims, thus giving a minimum bearing. Unfortunately, the joists were toe-nailed to each other and to the shims, and the shims were similarly nailed to the caps. The end elevation shows the three joists immediately under the arch rib to have been spaced 2 ft. centers and the two outside joists spaced 2 ft. 8 in., without bridging or intermediate struts or spacing strips.

The elevation (Fig. 2) shows the sequence of sectional pouring. It will be noticed that all but a small part of the rib had been poured over Bent 5 west, when the collapse occurred. Half-yard batches were trammed from

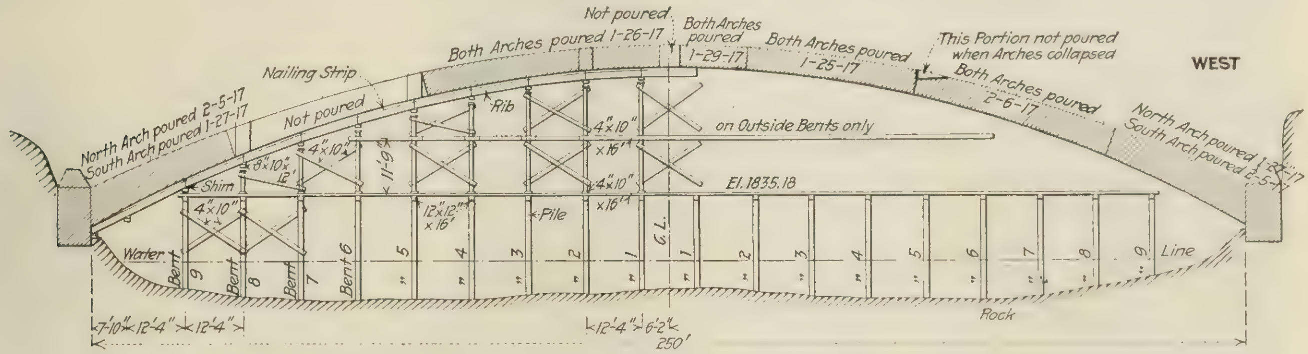


FIG. 2. OUTLINE OF POST ST. BRIDGE FALSEWORK, SHOWING PROGRESS OF PLACING CONCRETE

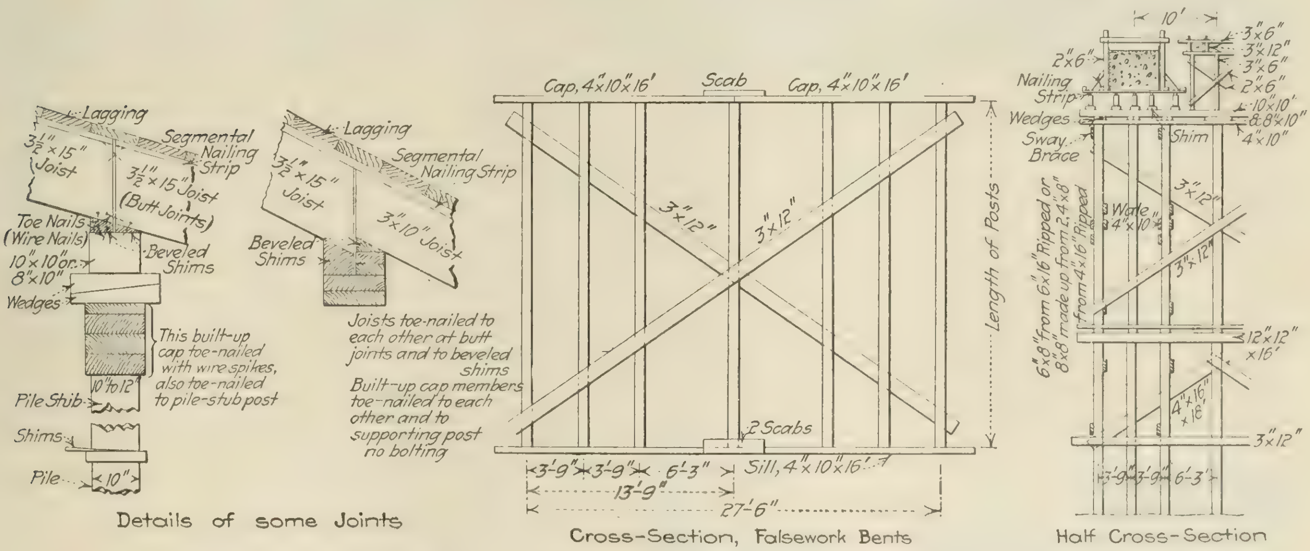


FIG. 3. DETAILS OF THE FALSEWORK DESIGN OF POST ST. BRIDGE AT SPOKANE

FIG. 4. CLOSE VIEW OF BENTS 7 TO 9 ON WEST SIDE OF POST ST. BRIDGE
Pile tops from 9 to 12 in. diameter. Note absence of bolts and presence of shims under half-story round posts

the mixer and dumped onto an inclined chute, from which the concrete floated or was spread to place. The writer's information from the workmen is that the dump over this bent was nearly a vertical drop. This would give a drop ranging from about 9 to 15 ft.

Mr. McCall examined all the points at which he believed any distortion might occur due to loading, about 30 min. before the collapse came. He found everything apparently undisturbed and in normal condition. Notwithstanding that the drop distance was gradually being decreased as the forms filled, it was from this point, in his judgment, he stated, that the collapse started. It is possible that the cumulative result of the impacts finally developed the critical weakness in the falsework and thus tumbled the whole structure into a mass of inextricable débris.

FIG. 5. LOOKING EAST OVER BRIDGE RUINS

The writer is deeply sensible of the deplorable and untimely end of the designer within a week of the collapse and ventures to believe that, were Mr. Kennedy alive, he could explain away much that may seem obscure and perhaps even justify a structure that to some of the profession would appear inadequate for the purpose it was designed to serve.

[A later telegram from Mr. Ralston states that the coroner's jury has decided that the structure fell from insecure piling and the falsework was unable to bear the weight of the concrete. It recommends that the city inspect all such falsework. Mr. Ralston also reports as follows: Fuller investigations show that the piles had little if any penetration, although driven to refusal and that the spiked bracing was the only means of preventing the kicking off of the frame from the sloping rock surface. The piles were shamefully small and the upper frame of insufficient size, there being 3000 lb. stress in the three joists under each rib. The voussoir sections as poured were too long and the neglect simultaneously to pour opposite sections in the two ribs undoubtedly distorted the falsework which, combined with the general flimsiness of the frame, the impact of the dumped concrete and the overstressed joist, caused the wreck.—Editor.]

Concrete Road Pointers from Papers at American Concrete Institute

Three of the papers on concrete road construction at the recent annual convention of the American Concrete Institute, at Chicago, Ill., Feb. 8 to 10, furnish the material for the following paragraphs. The subjects touched on are the present condition of the famous Wayne County (Michigan) roads, the maintenance of concrete roads in Connecticut and the western New York State practice in construction.

Wear and Maintenance of Concrete Roads

As to the Wayne County roads, A. N. Johnson, Consulting Engineer of the Portland Cement Association, admitted that there are a number of cracks in the roads, but he held that real defects are only such things as form actual or potential hindrances to traffic, and that so-called defects are of small account if easy and cheap maintenance is possible. He said that all the Wayne County roads, built in the last two or three years, are in most excellent condition, but that three stretches of the older roads are in bad shape.

These three stretches, he said, are the ones that are used practically entirely by the anti-concrete road men when they are citing the Wayne County roads. They are as follows: (1) A stretch which was a very poor job when built; it was not accepted by the commissioners as built, but was accepted with some hold-backs on pay. It was afterwards coated with tar. It has never proved satisfactory. (2) A section built of unwashed aggregate on which traffic was allowed too soon; it commenced to show decided signs of wear within three months, and was soon covered with a tar coating. (3) A section which never was in very good shape; it had apparently had some peculiar difficulty during construction. Mr. Johnson did not elaborate on it.

Most of the wear on concrete roads is at the joints, according to W. L. Ulrich, of the Connecticut State Highway Department. Other causes of maintenance expenditures are: (2) Small holes from local defects; (3) poor sand; that is, sand that has not good resistance to abrasion (in curing this, tar is broomed over the weak spot); (4) Concrete too wet; poor floating (this causes flaking, but is not of sufficient importance to require repair); (5) Longitudinal cracks which can not be accounted for so well, but probably are due to bad drainage and consequent dropping of the slabs at the sides. This is now taken care of by reinforcement.

Mr. Ulrich gave the following average costs of maintenance of roads in Connecticut for the last two years: Concrete roads, 25 mi., cost of maintenance and repair, \$38.63 per mi., or 0.4c. per sq.yd. of surface for annual maintenance; for drainage, \$28 per mi. per year, or 0.3c. per sq.yd. giving a total of 0.7c. per sq.yd. per year. For all other types of road amounting to about 1000 mi., the cost was \$585.18 per mi. per year or 6¼c. per sq.yd. These other roads average about three years older than the concrete roads.

Construction Pointers

William M. Acheson, Division Engineer, New York State Highway Department, read a paper "Essential Features for Successful Construction of Concrete Roads," which contained the following points:

Where soil conditions develop that cannot be corrected by replacing with a more stable soil, a subbase should be laid. From a study of the highways which were built in New York, Division 9, during the past two years, he has found the following type of foundation course the best for concrete pavement.

After the necessary excavating has been done and the subgrade properly drained, a layer of clean gravel from 2 to 4 in. in thickness is spread over the bottom. On this a layer of quarry or field stone is placed to the required thickness, depending on soil conditions. After the voids have been filled with clean sand or fine gravel and consolidated, the stone should be covered with at least 2 in. of coarse sand. This last mentioned sand layer serves the double purpose of regulating the subgrade and acting as a cushion to take the impact off the pavement proper.

Mr. Acheson is using reinforcement at every place where there is any doubt as to bad soil conditions. One of the essential features of the reinforcement, he said, is to be sure that it is in the proper location as to cross-section. It has been his practice to lay the first course of concrete and on this place the reinforcement, usually about 2 in. below grade by the use of wire hooks. It is then covered with the necessary 2 in. of concrete and the finished surface struck off.

Hard and fast rules should be laid down in regard to the aggregates, he said, for these were the factors in the successful construction which should never be deviated from. In this detail he said he differed from some engineers. If in certain localities the proper quality of material is not available without importing, and concrete was prohibitive on account of the resulting high cost, he said he would not attempt to build a concrete road. The question of proper coarse and fine aggregate is paramount in concrete road construction.

In the southwestern part of New York State, which is known as the lower tier, are sections which have been known for the scarcity of sands of the proper quality. In this section there were constructed a number of gravel concrete roads with thin bituminous tops, which were complete failures. By a careful material survey of this section, sand was found which passed the requirements by being washed. To have commercial sand and gravel companies install washing plants was a task, but this has finally been done, and it will not be long before contractors can be induced to install their own plants.

Surface Treatment

The surface of a concrete road should be screeded by means of a templet drawn with a short sawing action at right angles to the axis of the road, according to Mr. Acheson. A heavy screed should be used, and at the same time it should not be necessary to move this screed over the concrete surface more than once. Following this a "smoother" should be used. This is frequently referred to as a float, but the word float is a misnomer. The real intention is to smooth the surface so it will conform to the finished cross-section. This smoothing tool should always be made of wood.

Sprinkling with hand pots should be started as soon as the concrete surface will stand it. Hand pots should be used because the pressure from a hose on the first sprinkling is usually too severe on the surface. This should be done from one to two hours after the concrete

is placed. In this connection it is very essential that the hand sprinkling should be done several times before sod or earth protection is placed over the surface, and then after it is placed the pavement should be sprinkled at least twice during the day and once at night.

Mr. Acheson believes in a heavy split float for taking care of the joints, and the use of a long-handled float; which enables the operator always to work in a normal position over the bridge, also eliminating an additional man, who is necessary when hand floats are used.

The finishing should always be within 10 to 15 ft. of the screed, and this is impossible if the concrete is too wet. He advocates the brooming of a concrete road for the reason that the marks which the broom makes in the pavement aid in holding the moisture during the curing season. Care should be taken, however, to see that the broom marks are not too deep so as to start spalling and impede surface drainage.

Joints in the New York State work are placed every 30 ft. The reason for the adoption of 30-ft. joints is a practical one. It has been found that the transverse cracks which occur in the pavement average 30 ft. apart, and later inspections have demonstrated that this was a good decision, although the Highway Department is in an experimental mood and probably will try joints at greater distances.

One of the most important parts of a contractor's road plant in the construction of concrete roads is the water-supply. Mr. Acheson would advise at least a 5-hp. engine with a pump capacity of at least 200 gal. per min. The pipe line should be at least 2 in. and should have a tap at least every 200 ft. Wire wound hose should be provided long enough to reach half way between the taps. A great many mistakes have been made, he said, in regard to this particular feature.

Tile Drainage of Irrigated Land in Utah

By J. C. Wheelon*

During the spring of 1916, arrangements were concluded to install a tile drainage system on a 10,000-acre tract of the Delta Land and Water Co.'s project known as the "South Side Tract." This is an exceptionally beautiful and fertile tract, as deserts go, lying as smooth as a billiard table and having a fall to the south of 7 ft. per mi. The development work is being done under the Carey Act, and the company has installed the irrigation works, which (with the lands) will be turned over to the farmers. The farm tile drainage system is being installed to forestall the damage that usually follows the practice of irrigation, due to water-logged conditions of the soil and the concentration of alkaline salts to the detriment of growing crops. This trouble is indicated in the older irrigated settlements in the immediate vicinity.

Work Done by Force Account

The drainage work is done by force account, and the cost will be added to the price of the land to be sold to the settlers, who are employed to do all the work for which they have time and proficiency. The machinery, camps and shops are owned by the Delta Land and Water Co. and will be used on other tracts of land with a view to combine tile drainage with irrigation in future operations where this is found essential to the success of new districts. A. M. McPherson, project manager, of Delta, Utah, has organized this drainage system as a branch of his project work, and with the able assistance of C. C. Cramer, his chief engineer, has established working camps, shops, etc., on the tract, where the closest attention can be given the work. The main camp is seven miles east of Oasis, a station on the Salt Lake & San Pedro Ry., the nearest railway point.

*Consulting Engineer, Garland, Utah.

The drain tiles are furnished by the Utah Fire Clay Co., of Salt Lake City. The hauling from Oasis is done by farmers' teams and is paid for by the ton. The tiles are delivered along the route and distributed close to the proposed tile lines, as indicated by the surveyor's flags along the route. The tiles are placed many miles ahead of the excavation in order that they can be laid as soon as the trench is dug.

Electric-Lighted Ditching Machines

Three large 75-hp. gasoline traction ditching machines of the wheel-excavator type are now in use, with one or possibly two more to be ordered later. Two were built by the Buckeye Traction Ditcher Co., of Findlay, Ohio, and the third by Pawling & Harnischfeger, of Milwaukee, Wis. These machines are equipped with electric-lighting systems to enable the operation of night shifts. The maximum capacity in good ground in a trench 7 ft. deep and 20 in. wide is 2400 lin.ft. in 10 hr. for each machine. Owing to bad conditions that are encountered almost daily, the average is very good at 1400 ft. per 10-hr. shift.

Each machine operator is supplied with a blueprint map of the lines in his district. This indicates the survey, the location of the hub stakes, the flags at the intersection of branches, the depth to grade at each hub, the sizes of the tile to be used, the location of points where the size of tile changes and other useful information.

The soil is a sandy-clay loam for a depth of 3 to 4 ft., with a gradual change to fine sand as the depth increases. There is some quicksand at the lower depth of the trenches in places. As this kind of soil caves easily when waterlogged, a special steel shield is attached to the frame of the machine, just behind the digging wheel. This shield extends down to the bottom of the finished trench and forms a cab, which prevents the side walls of the trench from caving and which also carries the operator who lays the tile. The operator lays the tile as fast as the machine moves along, the tile being handed down to him by a man on the ground outside. The tile of all sizes are made in 2-ft. lengths. No 1-ft lengths of tile are used, as the longer tiles make for a better vertical as well as horizontal alignment and improve the flow line.

Some Handwork Necessary

One man follows behind the machine with a shovel and covers the tile with about a foot of earth, so that if the trench caves, this pad of filling will protect the tile from being thrown out of alignment by heavy clods of earth. The lines are left in this state of partial completion until several days have passed, so that if any poor workmanship has escaped the inspector, the accumulating waters flowing in the new drain will discover it and it can be remedied before the trench is filled.

The filling of the trenches is done with two teams of horses and drivers with a 3x12-in. plank 18 ft. long, strengthened with a truss to prevent its breaking. A team is hitched to each end of the plank, which is held on its edge by the weight of the truss at the back. The plank is laid across the trench, being of such length that one team travels on the outside of the spoil bank, while the other team travels on the opposite side of the trench. The team on the spoil-bank side travels somewhat ahead of the other, giving a slant to the plank that rolls the earth into the trench in a constant spray of fine soil that makes an excellent job. The filling is finished by plowing a back furrow onto the filled trench to provide dirt for settlement.

Some of the work is necessarily done by hand. Where permanent ditches and canals are crossed, special care is taken to prevent the water from finding its way into the tiles and exhausting their capacity. For this purpose concrete is poured over the tile while being laid, so that a thin jacket of concrete is formed for about 20 ft. each way from the center of the canal. Some difficulty was had in making the new earth over the trenches hold water in these canals. The new work settled and let out the water, filling the unfinished trenches with mud and water for many rods along the work. This was remedied by building a "riser" at each end of the jacketed section. This was a thin wall of concrete, about 5 in. thick, the full width of the trench and extending from the end of the jacket to the surface of the ground. Since this no trouble has arisen from that source.

Organization of Machine Crews

The crew for each machine consists of an engineman, who operates the apparatus and gages the course and depth and who can keep the machine in running order; one man to do the oiling, assist the engineman and set the targets on the line ahead; one man, in the trench cab, to lay tile; one to supply him with the tiles; and one man to cover the tile and help at other work, or five men for each crew. There is a general machinist who is available to go from one machine to another as troubleman, and an inspector who looks after all the work. A man with team supplies fuel, cement, sand and manhole sections, and moves concrete crew, etc. Two men do the concrete work for the several crews. These outfits are all doubled, as they work the machines in two 10-hr. shifts per day.

Preceding the work a complete map of the area to be drained was made, showing contour lines for every foot in elevation. Profiles of the water table were made by the use of 5-in. sounding wells 6 ft. deep, kept intact by a sheet-iron pipe and located 1/8 mi. apart both ways. As most of this tract had been farmed and irrigated for three years, these sounding wells are useful to determine the progress made in lowering the water during the prosecution of the drainage work. From this map the working maps were made showing the lines of tile, the manholes, peep wells, target hubs every 500 ft. (at which the depth to grade was shown), intersections of branch lines, open outfall ditches, all canal and road crossings, the sizes of the tile to be used and the points at which a change in the size of tile is to occur; also, any other information that will make for accuracy in fieldwork. About 15 mi. of open canal were built as outfalls and to take surface waste.

The largest tile are 12 in. in inside diameter. The smallest are 5 in. in diameter, about 70% of the entire system being 5-in. tile. The whole system is laid out on a uniform gridiron plan as near as possible, with the lines 450 ft. apart. The depth of trench is 4 to 7 ft., the average depth being 5.8 ft. The work is estimated to cost $20 per acre, everything complete.

Sand and Gravel Mixed at Source for New York Subway Concrete*

By J. G. Steinle†

In the New York City subways now under construction considerable difficulty has been experienced in finding adequate storage for concrete aggregates, especially in the lower parts of Manhattan, where the streets are narrow and the traffic heavy. This, together with the increased cost of cartage and the difficulty of keeping the numerous mixers supplied with the proper quantity of each aggregate, led to mixing the coarse and fine aggregates in the proper proportions at the source of supply and ship them ready mixed to the works.

At the present time there are two companies which ship the mixed aggregate. One company dredges from Long Island Sound, and separates the sand and gravel into various sizes, known commercially as 1½ in., 1 in., ⅝ in., ⅜ in., coarse grits, bird sand and rubbing sand. These various sizes are then remixed on conveyor belts in such proportions so as to make specification sand and gravel, and in passing from one belt to another and through chutes are properly combined.

The other company mines its product from the bank, washes it thoroughly, and then separates it into specification sand and gravel. At this plant the sand and gravel are hauled in cars to a loading pier especially equipped for mixing and loading. There are two hoppers on this pier, one for gravel, and the other for sand, which receive the contents of the cars and discharge it on a conveyor belt. The bottom of each hopper is closed by a bucketed wheel, which is so geared that the gravel hopper empties at twice the rate of the sand hopper. The mixture is then carried on the conveyor belt to the chute which delivers it to the boat.

In order to prevent segregation in loading, the boats are moved back and forth under the chute, which is always kept in a vertical position, or as nearly so as possible, because when the mixture is fed to the boat from a chute at any other angle, the larger particles, possessing greater kinetic energy, separate from the finer particles. The combined aggregate is not allowed to pile up, but is spread uniformly over the boat in layers 2 ft. deep. Field tests show that material on arrival at the mixer, after being unloaded from the scows and hauled through the streets is very little segregated, the proportions remaining practically the same as at the plant. In case of the 1½-in. mixture, it has been found that if it has been mishandled or rehandled too many times, it may become segregated, while ¾-in. gravel, mixed with sand, may be handled quite freely without danger of serious segregation, hence we find that the greater the variation between the extreme sizes of the component parts the greater is the danger of segregation.

*Part of paper read before American Concrete Institute, Chicago, Feb. 8, 1917.

†Assistant Engineer, Public Service Commission, New York City.

Notes from Field and Office

A sand that is difficult to handle—Driving concrete sheetpiles accurately—Partial paving of a street—Fill 130 ft. high to replace steel viaduct—Submerging 72-in. iron intake

"Rock Flour" Causes Difficulty

An unusual formation that many engineers and contractors have never before encountered is the cause of a suit for extra payment by a contractor on the sewerage works of the Metropolitan Sewerage District (Massachusetts). Borings along the line of the proposed sewer disclosed the presence of this unusual formation, but the difficulty of handling it was not recognized by either engineers or contractors.

The material is said to be a pure sand, but is finer than ordinary cement, which it resembles both in color and texture, although much more dense or compact than cement. When wet, this substance has the consistency of bread dough and is handled with great trouble. A shovel or other implement of excavation is forced into it with difficulty; and when the implement is lifted, the material flows away on all sides. It is said that a pile of this material as high as a man's head still retained the foregoing characteristics after remaining on the ground all winter.

The contract price for the sewer work was about $35,000, but it is alleged that the work cost the contractor just twice as much. The contractor is now suing to have the district reimburse him for part of the unforeseen cost.

Driving Concrete Sheetpiles True to Line and Position

By E. A. Bailey*

The construction of the Sacramento weir at Sacramento, Calif., a general description of which was published in *Engineering News*, June 22, 1916, p. 1204, includes the driving of a row of concrete sheetpiling 2000 ft. long under the crest of the wier to prevent seepage and consequent undercutting of the structure. The piles, extending through the sandy loam surface soil and penetrating a depth of about 4 ft. into a stratum of clay, vary from 18 to 26 ft. in length. They were designed, as shown in Fig. 1, with a slope, or as locally termed a "snipe," of 12 in. in 24 on the driving point. The contractor, believing that this was too sharp a point and that it would cause excessive friction, making the piling hard to drive, cast the first piles with a snipe of 4 in. in 12 in. When these piles were driven, however, it was found that the snipe given them by the contractor was insufficient to keep the point of the piles crowded tightly against the preceding pile, with the result as shown in Fig. 2. The points were then sharpened by chipping off the concrete to about the snipe given in the original design, after which no further difficulty was experienced in keeping the piling together.

The surface of the ground was soaked by means of water standing in the trench in which the piling was driven. No water jet was used. The piling was driven

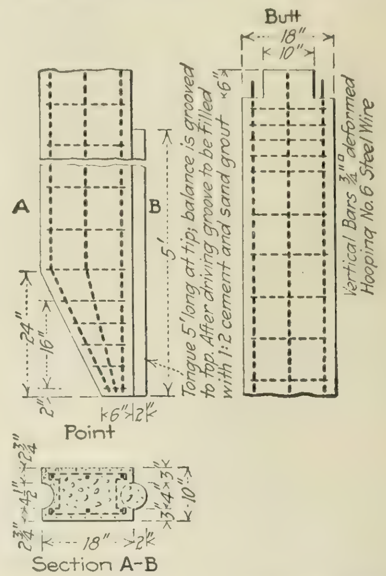


FIG. 1. CONCRETE SHEETPILE USED IN SACRAMENTO WEIR

with a Vulcan No. 1 steam hammer. The weight of the hammer was about 5000 lb., with a stroke of 30 in.

In driving the piling with heads constructed as designed the heads shattered badly in spite of any cushion that could be used under the hammer. A steel driving cap was made, which was placed around the head of the pile, the space between the pile and the cap being filled

FIG. 2. EXPOSED SHEETPILES, SHOWING BATTERED TOPS AND "CREEP" OF PILES

*Flood Control Engineer, State Reclamation Board, Sacramento, Calif.

with plaster of paris, as shown in Fig. 3. It was found that piling thus treated could be driven within 15 min. after the application of the plaster of paris, the best results being obtained by allowing about half an hour to elapse. Driving could be postponed as long as 24 hr. but it was found that beyond that time the plaster of paris had become so brittle as to disintegrate and allow the head of the piling to break as badly as it did without the plaster of paris. The last 200 piles were cast with

FIG. 3. PUTTING A PLASTER OF PARIS DRIVING CAP ON CONCRETE SHEETPILES

the head the full size of the pile, and these were successfully driven without the plaster of paris cap.

In Fig. 2 it will be noticed that the side of the groove on two of the piles was broken off for a considerable distance. This was probably caused by the point of the pile being deflected. There had been an old break in the river levee at this point, which had been repaired, it is said, by sinking a barge filled with cobbles. The driving was excessively hard at this point, which was taken to indicate that this obstruction had been encountered by the piling.

Excavations are being made for the piers at intervals of about 40 ft. to the depth as shown in Fig. 2, though not so wide. These excavations have progressed along about half the length of the sheetpiling, and thus far no breaks have been discovered in the piling except one not far from those shown in Fig. 2.

Wide Street Paving in Varied Strips To Meet Traffic Requirements

At Royal Oak, Mich., the problem of paving Washington Ave., 65 ft. wide between curbs, was solved by laying a narrow strip of concrete pavement on each side and leaving the remainder of the street for future treatment. A special feature of these concrete strips is that they are laid slightly below the finished grade and will eventually form the base for a future asphalt covering. This work extended for about 2600 ft.

The construction with concrete strips is shown by the cross-section, Fig. 1. The street is 65 ft. wide, with a parabolic curve giving a crown of 7 in. In the center of the street is a double-track street-car line of the Detroit United Ry. The rails are laid temporarily at the grade of the concrete paving, or about 2 in. below the established grade for the future asphalt surface. In each driveway is a 9-ft. strip of concrete paving 7 in. thick. This was originally designed to be of one-course reinforced concrete, but was changed to two-course concrete without reinforcement. The space between each strip

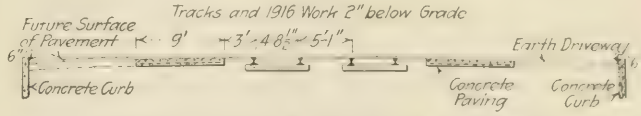


FIG. 1. STREET 65 FT. WIDE WITH TWO 9-FT. STRIPS OF CONCRETE PAVING, AT ROYAL OAK, MICH.

and the gutter is an earth roadway, to be paved in future with asphalt on a concrete base. The track space is not paved, but is filled with crushed granite and limestone screenings for the full width between the concrete strips.

For a distance of 1467 ft., where the width is less, the street is fully paved with brick and concrete. Here the track construction is of the standard design of the Detroit United Ry., shown in Fig. 2. The tracks are laid with 7-in. 91-lb. T-girder rails, in 60-ft. lengths, with 227-lb. cast-weld joints. They are connected at 6-ft. intervals by flat tie-bars $\frac{3}{8}$x$1\frac{3}{4}$ in., with threaded ends passed through the rail webs and secured by nuts. The rails are spiked to wood ties 6x10 in., 6 ft. 8 in. long, 20 ties to a rail, with a spacing of about 3 ft. c. to c. For each track there is an 8-in. concrete base, the $28\frac{1}{2}$-in. space between the slabs being trenched for a tile drain and filled with slag. For paved streets each tie rests on a 1-in. sand cushion, and concrete is filled around and over the ties, covering them with a $2\frac{1}{2}$-in. layer.

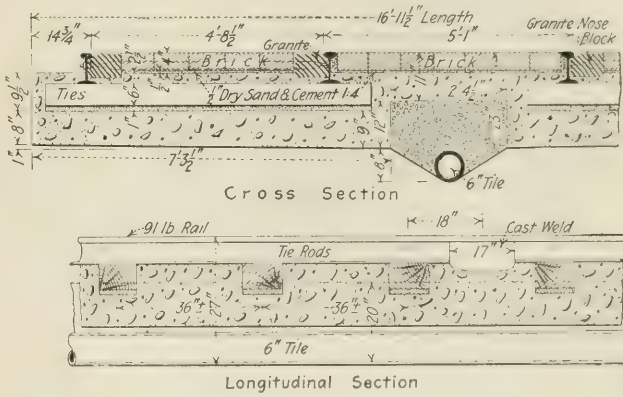


FIG. 2. STANDARD TRACK CONSTRUCTION FOR PAVED STREETS; DETROIT UNITED RY.

For brick paving there is a ½-in. sand cushion. At Royal Oak, however, the paving between the rails is of concrete, with granite nose blocks along the inside of each rail to form the wheel groove.

In doing the trackwork a single temporary track was laid at one side of the street, and car movements were governed by hand-operated block signals, consisting of a group of electric lights on a post at each end of the single-track section. The concrete work was done by the R. D. Baker Co., of Detroit, which had the contracts both from the village and the railway company. The trackwork was under the direction of John Kerwin, Superintendent of Tracks, Detroit United Ry. The Southern Michigan Engineering Co., of Royal Oak, Mich., acted as engineer for the village.

Steel Viaduct Replaced by Fill Dumped from Second Steel Trestle

When the Bessemer & Lake Erie R.R., in 1896, built its Allegheny River bridge, it was foreseen that the growth of traffic would eventually render double tracking of the road necessary. Therefore foundations and footings capable of carrying the piers of a double-track bridge were provided, although the masonry was only carried up in single-track width above water level.

The increase in traffic came, until the throttling effect of this half-mile section of single track in what has become largely a double-track road influences the capacity of the entire system. But along with the growth in the volume of traffic came the tremendous increase in weight of the units in which and by which it is moved, to upset calculations. Today double-headed trains of one class of engines on reaching the bridge must stop and send one of their engines over ahead or put it on behind as pusher, to avoid concentrating the engine loadings.

Faced with the problem of providing another track over the river and with this growing inadequacy of the existing spans, the railway company decided that in the interests of ultimate economy and safety it was better to scrap the entire superstructure than to add to and reinforce it. The new plan provides for placing a third of the length of the existing bridge once and for all beyond the reach of depreciation and obsolescence, by converting it into fill.

The old bridge (see Figs. 1 and 2) is on a grade of 0.48% going toward Pittsburgh; the new base of rail will be level, starting from the same elevation at the south end and running 17 ft. above the old grade at the north end. The new superstructure will be designed for two lines of E75 loading, and there will be two triple continuous trusses and one simple truss span, all of "high" steel. Work now under way consists of extending five of the old piers to double-track width, building two new piers and one abutment and making the north fill. The "Bessemer," a United States Steel Corporation subsidiary, brings ore from the Great Lakes to the plants of the parent company in the Pittsburgh district. It also has to dispose daily of a large tonnage of refuse from those mills and furnaces. This fact affects considerably its construction economics. The profile for its recent grade-reduction reconstruction shows the far greatest portion in fill, with no attempt at balancing. While its cuts cost it presumably as much as any other road, its fills cost much less; in fact, the slag must be dumped somewhere.

FIG. 2. GENERAL VIEW OF RIVER SPANS, PRESENT ALLEGHENY RIVER BRIDGE, LOOKING NORTH

A permanent embankment 130 ft. high is therefore to replace about 1200 ft. of steel viaduct at the north end of the Allegheny crossing, leaving an ample clear waterway of about 2400 ft. under the river spans. It will contain 1,200,000 cu.yd. of slag and is being placed at a rate of about 3500 cu.yd., or 120 cars, a day.

It is common practice in Western railroad practice for framed timber trestles to be erected during construction of a line and used for a number of years until eventually buried in fill, made by dumping from them. But it is not often in any part of the country that a perfectly serviceable steel viaduct is treated in this way. In the building of the north embankment of the Allegheny River bridge two such viaducts, side by side, are being buried. One of these is the main-line trestle, which is left in place to carry traffic, as traffic must be carried until the completion of the new earthwork. The second viaduct, Fig. 4, was erected alongside as a dumping trestle, because train movements over the bridge are too incessant to allow dumping from the main track. The high north bluff made it impracticable to get down to a low pile dumping trestle such as had been used in making the 4,000,000-cu.yd. Culmerville fill a few miles away. Culmerville embankment, which has been under construction for three years past, required four pile trestles to raise it to its maximum height of 185 ft.

The line change at Culmerville released from service a steel viaduct 135 ft. high and 1400 ft. long. This, then, was taken down, and the towers and tower spans were

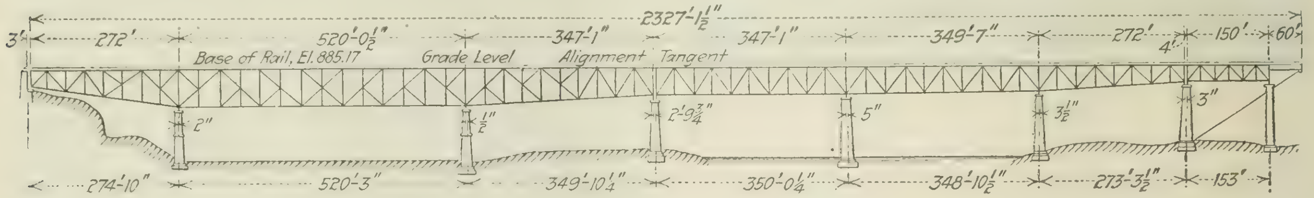


FIG. 1. OUTLINE ELEVATION OF NEW ALLEGHENY RIVER BRIDGE OF BESSEMER & LAKE ERIE R.R.

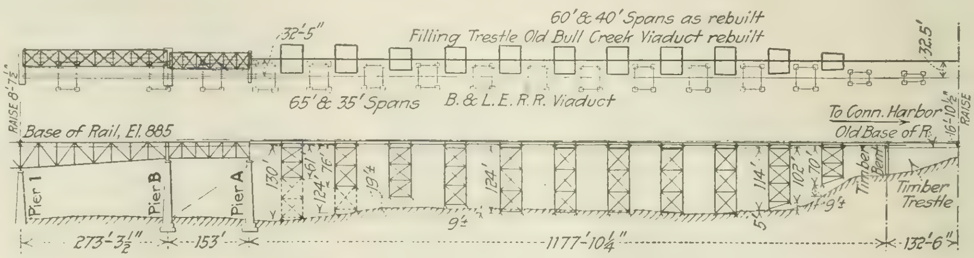


FIG. 3. POSITION OF FILLING TRESTLE ALONGSIDE NORTH APPROACH VIADUCT

brought to the new Allegheny bridge site and reërected alongside the main-line trestle. In order that the embankment might be centered on the new bridge line, it was necessary to crowd the filling trestle over to within 32.5 ft. of the centerline of the old bridge, as shown by the pedestal locations in Fig. 3.

The old bridge viaduct has 65-ft. and 35-ft. spans, while Culmerville (or Bridge 10) viaduct in its original location had 80- and 40-ft. spans. The dumping-trestle towers were erected on 100-ft. centers, to clear the other towers, and 60-ft. girder spans that the railroad had on hand were used instead of the 80-ft. spans. The 60-ft. spans were narrower and shallower than the 80-ft. spans and so rest on a pair of I-beams, spanning the column caps at each end. Ties on the dumping trestle are spaced 2 ft. on centers.

Some other adapting was also required because of the varying height of the Culmerville towers, the center ones being about 10 ft. too high and the ones erected toward the Allegheny River end being from 19 to 69 ft. too

FIG. 4. VIEW OF FILLING TRESTLE AND PIER A, NORTH APPROACH TO ALLEGHENY RIVER BRIDGE

short for the new location. One story of new steelwork was added to one tower (Fig. 3), two to another, one that lacked but 19 ft. was set up on pile bents of that height, and the foundations for the ones that were too long were set in pits about 15 ft. below the surface. In these last cases the foundations were 4 ft. of concrete on gravel; where the column footings came above the ground level, pile pedestals were used. All the field connections were bolted.

Handling the Slag for the Fill

The trestle can accommodate about 30 cars at one time, and 120 cars containing about 3500 cu.yd. is the amount of refuse usually received at the bridge site daily. It is loaded in cars of various types, some of which require much shoveling to empty, as the mills must load whatever cars come to hand to get the waste out of the way. Practically all the refuse consigned to this fill is a vitreous openhearth slag, along with some blast-furnace slag. This material makes a stable fill, with a minimum of slippage and settling, and takes about a 1½ to 1 slope. It varies in size from dust to two-man-size lumps. The big pieces batter up the bracing of the trestles badly; but since the towers are constantly shortening in height above the fill, this effect is not serious.

The dust threatened to be more troublesome, as a breeze would float it over the surrounding farms and create a serious nuisance. A standard 50,000-gal. water tank was erected on the bluff, and every car is well wet down before being run out on the trestle. Besides keeping the dust from flying over the country roundabout, this treatment improved working conditions materially for the men engaged in cleaning out the cars.

There is one type of mill refuse, however, that cannot be handled with even this precaution. This is flue dust. It will not wet down, being practically impervious, and cars known to contain it are sent on to other locations better adapted to its handling. Occasionally an unpleasant surprise is sprung by a car half-filled with flue dust, concealed under a layer of some other material.

This work is being done by company forces, under the direction of H. T. Porter, Chief Engineer. W. H. Slifer is Resident Engineer.

Laying a Submerged 72-In. Cast-Iron Intake Main at Syracuse, N. Y.

(Contributed)

To serve as an intake for the water-supply of the Solvay Process Co., Syracuse, N. Y., 1250 ft. of 72-in. cast-iron pipe has just been laid in the bed of Onondaga

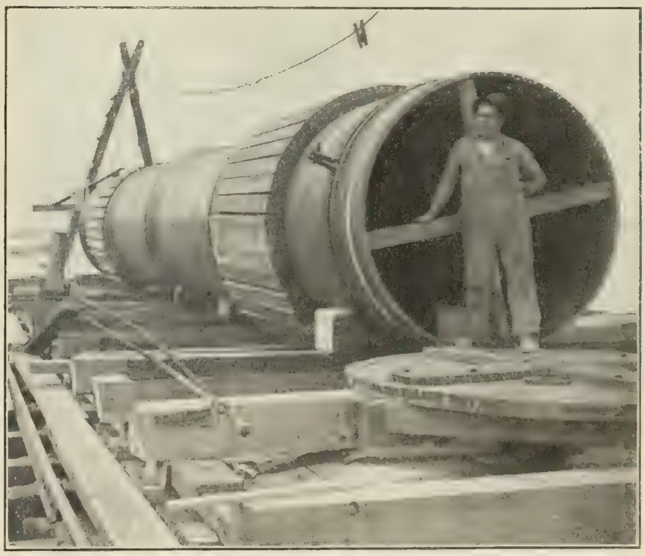


FIG. 1. FOUR LENGTHS OF 72-IN. PIPE ON WAYS READY FOR LAUNCHING

Lake at depths varying from 12 to 60 ft. This is one of the largest submarine pipe-laying jobs on record. The work was done by the Great Lakes Dredge and Dock Co., Buffalo, N. Y.

The shore end of this pipe line was cast into a reinforced-concrete well, the bell end of the pipe being in the well, from which point the pipe-laying in the lake began. The pipe line was laid in sections of 48 ft., made up of four pieces of pipe 12 ft. long, each weighing 8 tons. The sections of pipe were put together on a wharf, lined up, leaded and calked with plumbers' oakum, leaving not less than 2½ in. of the joint to be poured with lead. The spigot on the end of each 48-ft. section was specially

tapered, and this point was calked and poured ashore and then pulled apart, so that no calking under water was necessary.

After the joints were calked and leaded, wooden bulkheads were placed over each end of the section, held in place by 1¼-in. rods running the whole length of the pipe on the outside. These bulkheads were provided with gaskets that made them water-tight. A 5-in. gate valve was placed in each bulkhead, so that water could be let into the pipe when it was ready to be sunk into place.

The 48-ft. section of pipe, when ready, was rolled on ways from the wharf into the lake, where it floated with about 18 in. out of water. The work of lowering the pipe was necessarily of a delicate nature, as a very trifling distortion would have broken a joint. A section of pipe line was towed between two sets of pontoons, which were made up to form a catamaran.

On this catamaran were placed a hoisting engine and two four-leg A-frames, one at each end, to which was attached a set of four-sheave blocks, equipped with chain

FIG. 2. LAUNCHING WAYS FOR FLOATING 48-FT. SECTIONS OF PIPE LINE

slings leading to each piece of pipe. After the slings were properly attached, the valve was opened and water admitted; and the process of lowering to place began.

As soon as a section of pipe was filled with water, the bulkheads were taken off and towed back to shore, to be used on the next section. A diver, by a code of signals, directed the movement of the pipe, which was accomplished by anchors leading in different directions, so that the catamaran with its load could be moved in any direction and any distance. After the spigot end was entered, it was only necessary for the diver to adjust the spacing clamps and screw up the two 1½-in. bolts that held them.

The pipe was laid to a gradient on three different slopes, the shore end being 12 ft. under water, while at the intake cage it was 60 ft. below the surface. In places the character of the bottom necessitated the use of cradles, which were attached to the pipe before it was sunk; otherwise the entire line was on bottom.

As an indication that the joints were exceedingly tight and the work was thoroughly done, it was noticed that while the diver was working in the pipe, at the outer end, air bubbles from his helmet passed through the pipe line from the outer end and escaped into the well 1200 ft. from the point at which he was working, and did not appear at any other place in the line. This was satisfactory proof that the joints were all tight.

The intake cage is box-shaped, made up of three sections 9-ft. square and bolted together, the top section being provided with vertical rods at 1½ in. c. to c. to prevent any foreign matter larger than ¾ in. entering the intake. Leading from the four corners of the cage are 1-in. cables, about 100 ft. long, to which are attached concrete blocks weighing about two tons each. These cables serve as guys to maintain the cage in its vertical position.

FINE AGGREGATE

Snow Guards of Old Crossties have been built by the Boston & Middlesex Street R.R., near Boston, Mass. These are cheap and have proved effective.

Efficiency of Track Gangs at Night was the subject of a question-box symposium in "Aëra," the organ of the American Electric Railway Association, for January, 1917. Out of 14 electric-railway men replying, only one reported night work advisable; this man (H. S. Cooper, Secretary of the Southwestern Gas and Electrical Association, Dallas, Tex.) found results dependent on quality of illumination provided. The general opinion was that 20 to 50% more work could be done in the daytime and that night work should be done only in case of urgent necessity. One company (Lehigh Valley Transit Co.) found greater loss of supplies. Extra wages are generally paid for such night work.

Overtime for Steam-Shovel and Dredge Men—The Reclamation Service has adopted the following rule to form the basis for overtime payments to steam-shovel and dredge men:

Time and one-half for all overtime, except when moving or digging with machine on Sundays or holidays, which shall be paid for at the rate of double time; the following holidays to be observed: New Year's Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas.

According to the United States "Reclamation Record" for February, this rule applies to enginemen, firemen and cranemen employed on shovels and hydraulic dredges. The rule is to be incorporated in the contracts for employment.

Setting Grade Stakes for Bridge Approach—In grading and repaving the curved and raised approaches to the Cambria St. bridge, Philadelphia, the street surface and curb and gutter heights were first worked out by the help of a contour plan drawn to a scale of ⅛ in. to the foot, with 0.1-ft. contours. To transfer the final design to the ground the method adopted was laying out a system of points on 10-ft. squares, finding the grades of these points by interpolating between contours, and setting and marking stakes accordingly. The labor of setting these stakes was not great, and the resulting pavement surface corresponded more nearly to the predetermined one than could have been obtained by the eye or by the use of level boards.

Suggestion for Binding Engineering Papers—LaVerne J. Ruddock, structural engineer, Wheaton, Ill., uses an inexpensive method of binding his technical periodicals, and passes it on to readers of "Engineering News." He says: "(1) Take the advertising pages off both front and back and remove the staples from all the copies of a volume (half-year, usually). (2) Take two pieces of ⅜-in. board about 3 in. wide and 18 in. long; place one length on the front and the other on the back, allowing a scant ½ in. of the back of the papers to project through. Place a clamp on each end and screw tight. The clamps are small cast-iron bracket clamps obtainable from the hardware store for about 10c. each. (3) With a saw make six or seven cuts into the back of the papers about ⅜ in. deep. Cover the back with glue. (I obtain 'pad paste' from a local job printer.) (4) Draw a string into the cuts made by the saw and lace the back three or four times. Take a strip of cloth and cover the back where the glue has been applied; remove the clamps and boards and allow the glue to dry out for a day or two before use."

Editorials

Water Content in Concrete Must Be Quantitatively Determined

There must be a few men in the concrete industry today who view with mingled resentment and pride the current agitation regarding the proper amount of water for mixing concrete. These men, whose number is not large, are those who for some years past have been trying to urge upon the profession the dangers of overwet concrete and the need for a thorough experimental investigation of the problems of the use of water. Their resentment must be roused by the apparent novelty given the question by those now most concerned in emphasizing it; their pride is naturally due to the recognition of their early efforts, if not of themselves.

But regardless of such personalities there is much that is hopeful in any movement looking toward the rational measurement of water in concrete. To an outsider, for instance, it is most unscientific that we should demand utmost precision in all the factors that go to make concrete and leave one important ingredient to chance or to the inexpert judgment of a mixer foreman. The more we have of such investigations as are reported by Professor Abrams on another page the nearer we will be to perfection in concrete manufacture.

The progress of this question of water in concrete is interesting. There are men still young who remember the day when they stood over the laborer until he rammed the reluctant water to the surface of the concrete. Then came the time when it was only the old fogy who forced this extreme, the "sloppy" mix became triumphant and the water stood ankle deep on every new-laid batch. About then, one rightly regarded as the dean of the engineering profession said in public meeting that he was glad "that the pernicious habit of using dry concrete was fast disappearing." From this extreme the reaction has been slow, but beginning with the Joint Committee's delightful ambiguity that "too much water is as objectionable as too little," the pendulum is on its way back.

What is needed now is some exact criterion of measurement, some simple method by which the proper proportions of mix can be changed from batch to batch, if need be, to produce the optimum result in the finished concrete. It is well enough established that water content is important; the demands now are quantitative, and the laboratory efforts must be toward that end.

The Price of Water Meters

The great increase in the price of water meters has moved the Finance Commission and Mayor of Boston to ask the legislature for a repeal or suspension of the statutory requirement for annually metering 5% of all old services and all new service connections. The inference of the Finance Commission's report, abstracted elsewhere in this issue, is that the present high prices are not justified, and while the report distinctly states that there is no evidence of collusion among the members of the Meter Manufacturers' Exchange, nevertheless it shows that such a possibility was in the mind of the Commission.

Without attempting to pass on the merits of either side of a controversy, which because of local conditions may or may not have much general significance, it is well to remember that there are some obvious and unquestionable reasons for the increasing prices of water meters. Every one is only too familiar with the increased cost of *everything*, since 1915. This is particularly true of brass, bronze, copper, and rubber products, all of which are used in the manufacture of water meters. More than the increase in the cost of these products has been the increase in cost of skilled metal workers, who are in such demand by munition manufacturers.

Moreover, uncertain industrial and market conditions make large bids very hazardous. Proof of this is contained in bids recently opened in Newark, N. J., for water meters. The Union Water Meter Co. bid \$8.50 each for 3000 meters of ⅝-in. size, but \$9.50 for 5000 meters, bidding the higher price to protect itself against a possible rise in prices during the manufacture of the meters.

In Newark eight bids were received, the lowest being that of the local concern, the Gamon Meter Co., for \$7.65 each. This company, it will be noted, is one of the two mentioned in the Boston Finance Commission's report as not being in the Meter Manufacturers' Exchange. The Boston prices, given in the article referred to, include connections.

It is an unfortunate time for meter prices to jump, just when water-works officials have succeeded so well in convincing water boards and legislative bodies that the meter method is the only proper way of selling water. Let it be hoped that the arguments which may justify a temporary suspension of meter installations in Boston will not be used to counteract the good work done elsewhere in helping to put water-works departments on a more business-like basis.

Engineers Would Welcome Better State Government

The Department of Public Domain proposed in the bill before the Minnesota Legislature (*Engineering News* of Feb. 15, p. 293) is a move in the direction of simpler, more responsible and more efficient state government that seems bound to appeal to engineers. Ten or a dozen boards, commissions and offices would be combined into a single department, under a single director. The various functions, some ill defined, would be regrouped under five bureaus each headed by a commissioner responsible to the director of the whole department. Two of these commissioners—Highways and Drainage and Water—would be engineers, and every one of them would have to be "an expert in such matters" as pertain to his bureau, selected without regard to political affiliations.

Another and a more sweeping move in the same right direction has been made in Illinois, where a legislative bill fathered by Governor Lowden provides for consolidating more than a hundred state boards, bureaus and commissions into nine departments, each headed by a director. The proposed Illinois departments are: Finance, Agriculture, Labor, Mines and Minerals, Public Works, Charities and Corrections, Public Health, Trade and Commerce, Registration and Education.

Each of the Illinois directors, like the proposed Director of the Public Domain in Minnesota, would be appointed by the Governor with the approval of the Senate. Each director could therefore be held clearly responsible for the acts or negligence of his department, while the appointing power, in turn, would be responsible to the electorate. It is open to question whether the Governor should not be solely responsible for all administrative appointments, instead of sharing responsibility with the Senate, but perhaps that would be going too fast and far at this stage of American governmental reform.

This proposed state legislation is in direct line with the simplification in municipal government that forms the central feature of the commission plan adopted by half a thousand cities in the last decade, with its sweeping away of numerous uncoördinated and often conflicting boards and commissions and divided responsibility. It is better than the commission plan in that each state department would have a single head instead of many heads.

It is sincerely to be hoped that the Illinois and Minnesota bills, at least in essence, become laws, in order that fair trial may be given to a more simplified and efficient system of state government than is now in vogue. It is high time for the states to fall in line with the cities in the matter of governmental reform.

Increased Steam Distribution in the Streets of New York City

It has been many times predicted by engineers familiar with subsurface conditions in the crowded streets of lower New York, that eventually the commercial distribution of steam through these streets by the New York Steam Co. would have to be abandoned. That there is no present prospect of this prediction coming true is apparent from the fact that a new steam generating station has just been completed by the company, near the East River waterfront on the lower end of Manhattan Island, to take the place of the old Dey St. Station, which was the original plant built by the company. The boiler capacity of Dey St. is about 16,000 hp. The new plant will have 12 boilers, capable of furnishing 24,000 hp.

A surprise in connection with the steam company's business is that a considerable part of the steam distributed is used to develop power. Over 50% of the steam from the downtown station is so used, and more than 20% of the steam distributed from the uptown plant. Other systems of power distribution, which were in extensive use 30 years or more ago—the compressed-air, the hydraulic, and the endless rope systems—have generally been abandoned on account of the superiority of electric-power distribution. The New York Steam Co., however, notwithstanding the heavy conditions encountered in the crowded streets through which its mains pass, continues to expand in business. The importance of the power development side of the business is indicated by the fact that the company proposes to increase the steam pressure in its mains to 125 lb. at an early date, and contemplates eventually raising it to 150 lb.

The company now distributes over 14 mi. of steam mains laid in the streets. Two and a half years ago it was required to replace all its steam mains with new lines thoroughly protected from heat loss by hollow-tile walls, asbestos and mineral-wool covering, as described in *Engineering News*, July 30, 1914.

About 59,000 lin.ft. of street mains had to be rebuilt to conform to these requirements, and about 12,000 lin.ft. of this reconstruction has already been done. The reconstruction is required by the city to protect the other underground pipes and wires in the street from the damage due to the escaping heat from the steam mains. The steam company has been partially compensated, however, for the heavy expense of this installation by the reduction in the amount of heat which it loses between the station and the consumer.

What Is the Matter with Expert Witnesses?

So much dissatisfaction is reported about engineers as expert witnesses that it challenges attention. Some of the complaint is that engineers in court are unable either to help their clients or to illuminate the court on technical questions presented by a case, and that they thereby fail to earn the place in public esteem to which the profession is entitled. The rest of the volume of complaint is that experts employed by public and private interests in utility cases differ in their findings of value for condemnation or ratemaking so widely as to constitute a public scandal. Often both sorts of complaints arise in the same case. Though incidental relations exist in the causes of these typical complaints, the two classes of trouble must be considered separately in an effort to trace their source.

It is, alas, too true that in conspicuously few cases do the knowledge of the engineering expert and the art of the good witness dwell within the same human frame. There are a few engineers, however, who are recognized both for the lucidity of their explanations from the witness chair and their ability to baffle the wiles of the uncandid attorney. But of the practice which these men employ to such ends, all too little has been reported. Herein has existed a definite gap in our engineering literature—a gap which many have found but few have aspired to close. It is a real pleasure therefore to call attention to the unique contribution elsewhere in this issue in which are depicted the peculiar elements which may be conceived as making up the "art of the expert witness"—his realization of his modest place before the court, his confidence in his technical knowledge, his subordination of his efforts to rules of evidence, his care in producing definite impressions on the court, etc. A few men may naturally possess these arts, but obviously others may acquire them to a great degree.

The existence of differences in opinion and finding of facts between the experts on opposing sides of utility cases in most cases is merely indicative of the existence of a controversy. In many cases the differences in finding of facts measure the size of the controversy. The existence of a controversy with two sides presupposes the pos-

sibility of different basic hypotheses laid down by counsel for one side and the other, each capable of more or less creditable support. There can be no great blame cast on engineers for building up different structures of expert testimony when the foundations and materials given them differ as radically as they do.

Yet evidently there is an opportunity for reducing the differences between the opposing experts in valuation cases—in such matters, for instance, as regard the physical facts to be ascertained by duplicate technical inspections, though the differences which thus may be harmonized constitute at present a rather minor trouble in view of the larger discrepancies which arise from the diverging hypotheses of opposing sides.

It is obvious, therefore, that both classes of complaints that we have mentioned may be very largely dissipated. The first variety will disappear with a little more intelligent effort on the part of the engineers who appear in court as expert witnesses. The second variety, if it has any merit in its basis, must be transferred to other shoulders, to the men who direct the procedure of commissions and corporations.

When Doctors Disagree

Th so-called repudiation of the report of the Joint Committee on Concrete and Reinforced Concrete on the floor of the recent convention of the American Concrete Institute was not so radical an act as it has been made to appear in some quarters. What happened was that the meeting, by a vote of 13 to 9, out of certainly 70 members present, voted to pass to letter ballot a building regulation framed by a Commitee of the Institute, which regulation contained numerous provisions at variance with those just adopted in the final report of the Joint Committee, in which the Institute was a participant. A later equally well attended meeting voted 17 to 9 apparently—the procedure was somewhat devious—to accept the regulation but to withhold sending it to letter ballot until next year. At the same meeting the report of the Joint Committee was received but not discussed, as it had not been before the Institute the requisite 30 days prior to the convention.

This was all rather unrepresentative and was obscured by the customary parliamentary wrangles. So far as the floor meetings go they were quite unimportant. The committee reports themselves, on the other hand, are important and it can not be denied that the general situation developed will be confusing. The coming *Proceedings* of the Institute will contain two more-or-less similar reports on the design of reinforced concrete which differ widely on some of the most important details of present-day designing, details on which many are looking for authoritative pronouncements. That neither of these reports will have the acceptance by vote of the entire Institute is immaterial; they both bear the signatures of expert committeemen and will from that fact and from the fact that they are printed have wide circulation and acceptance. The trouble will be that the seeker for authority in design on the disputed points will be helped but little, except as he is benefited by the explanation of some of the provisions the printed discussion will develop or unless he has personal preference for the expert ability of one of the two groups of signers.

The moral of the whole matter is that it is impossible at this early day to lay down exact rules for certain phases of reinforced-concrete design—notably for the design of the girderless floor or flat slab. The hope of some members of the Joint Committee that the debatable questions before them had been settled for some years, at least, is already shown futile. That the dominating members of the Concrete Institute's committee are men engaged in the construction of concrete buildings is important just as it is important that the designer's viewpoint appears to weigh heavy on the Joint Committee, but this very distinction points to some hard sledding for the Joint Committee's report in the future. As this journal pointed out a month ago, an immediate successor to the Joint Committee would not have to pass its time in idleness; there is still work in this field.

Letters to the Editor

Conditions in the Boston Public Works Department

Sir—An editorial and news item relative to conditions in the Boston Public Works Department, the High-Pressure Fire Service and the Fire Department appeared in your issue of Jan. 11. The engineering prestige given the subject by your periodical requires that we correct wrong impressions and misstatements of fact contained in that published statement.

The 17 men whose discharge was referred to were not "fired" by the honorable mayor because they had not been active in reëlecting him, but were dropped by the Commissioner of Public Works because they occupied supervisory positions where their services could be dispensed with to the city's advantage. Thirteen of these men have since been reinstated in the city's service for duties other than those formerly assigned to them. Three whose positions were abolished appealed to the court for reinstatement, and final action is still pending in the Supreme Court. One of these was the division engineer of the Sewer and Water Division, who, under the former commissioner, organized the High-Pressure Fire Service in August, 1911, and subject to the approval of the commissioner was in full control of its activities for 4½ years.

There was selected to have direct charge of the High-Pressure Service an engineering inspector who was in the employ of the National Board of Fire Underwriters, with whom he had had about four years' experience inspecting the water-supply and fire-department equipment of various cities for the purposes of fire protection.

When this selection was made, there were employed in the Public Works Department as engineers with civil-service ratings at least six men whc were better fitted by education and experience to handle the problems of high-pressure fire service than the new man. This appointment had a much more harmful "effect upon the morale of the department and the willingness of progressive men to enter its service" than the separation of the division engineer and one other from the Water Service responsibilities.

The engineer in charge of the High-Pressure Service was not dismissed from the department. Just previous to November 20, 1915, after personally investigating the High-Pressure

Fire Service installation, I decided that I would not accept the division engineer's recommendation to certify to the Civil Service Commission that this official was an expert in this work for a further six months' extension of his employment, and he was automatically dropped, not having taken, during his four years' service with the city, any examination under civil service.

The statement that the leakage was raised from the specification requirement of ½ gal. per lin.ft. of joint in 24 hr. to 4 gal. or about double that allowed on any similar system, is misleading and untrue. The ½-gal. rate is practically impossible to expect in pipe lines backfilled before testing, as were practically all those installed by the engineer in charge; and the Manhattan high-pressure pipe-laying specifications, dated Jan. 1, 1913, in paragraph 255, state that 4 gal. is the rate allowed; and that this requirement obtained throughout the 127 mi. is confirmed by an article by Max Blatt in the "Journal" of the New England Water-Works Association for December, 1915.

Your reference to my being a politician may be refuted by the fact that, excepting 1½ years, I have been employed continuously by the City of Boston in the engineering branch of its service since 1887 and have qualified through the Massachusetts Civil Service Commission for its highest rating as engineer.

The successful handling of a recent dangerous and threatening fire on Chauncy St. in the heart of the business district by the Fire Department was referred to editorially by the Boston "Globe" and the Boston "Journal" as a sufficient answer to the unjust criticism made by the National Board of Fire Underwriters as to the discipline and efficiency of this department.

The allotted space will not permit me to reply to other misstatements of fact that you have published as extracts from the report of the National Board of Fire Underwriters, some of which were brought to the attention of its chief engineer at a public hearing on the High-Pressure Service recently held in the mayor's office in this city

E. F. MURPHY,
Commissioner of Public Works.

Boston, Feb. 7, 1917.

[Mr. Murphy's statement of the case of the 17 discharged employees should be supplemented by the facts contained in "Engineering News," Jan. 27, pp. 184, 193, and Feb. 10, p. 291, for the year 1916. The reason why Mayor Curley reinstated 13 of the 17 employees was because such men as Frederic P. Stearns, Desmond FitzGerald, Henry F. Bryant, Charles T. Main, Harrison P. Eddy, Frank A. Barbour and Edward C. Sherman took the lead in publicly denouncing this act as "a disastrous blow, which not only affects most seriously the present efficiency of the department, but will, unless it is counteracted, lower the standard of efficiency to a still greater extent in the future."

It should also be noted that the decision of the City Court in ordering the reinstatement of the other three employees was "that the order of removal was made without proper cause and in bad faith." Their case is now before the Supreme Court of the state, on the mayor's appeal.

The other statements that Mr. Murphy takes exception to are contained in the report of the National Board of Fire Underwriters.—Editor.]

Training Teachers of Engineering

Sir—The article in your issue of Feb. 8, by A. M. Shaw, on "Should Not Engineering Teachers Know How To Teach?" has been read with great interest by the writer, who heartily agrees with Mr. Shaw in many of his statements and especially in his criticism of the ability of engineering teachers.

During the last five years the writer has strongly advocated the elimination of a great deal of the highly specialized instruction that is given at the present time in most of our technical schools. During a four years' course it is only possible to give the student a thorough training in the broad, fundamental principles of pure and applied science. The specialized and advanced work should be left for graduate study. The elimination of many of these specialized courses would provide for the introduction of more work in the important cultural subjects that are necessary for the broad training of the student. With reference to graduate work, the writer ventures to quote from an address which he gave last June before the Society for the Promotion of Engineering Education:

> Those technical schools which have the proper resources, teaching staffs and equipment might offer advanced courses in special branches of applied science. These advanced courses could be profitably taken by those students who had attained marked proficiency in their previous scholastic work or by practicing engineers who might desire to secure special training. Advanced degrees could be appropriately awarded for the successful completion of prescribed courses of study.

The writer has often deplored the custom in most technical schools of assigning the younger and less experienced teachers to the freshman and sophomore classes, while the older and abler teachers take charge of the upper-class and graduate instruction. It is self-evident that the freshman class especially needs the attention of the ablest teacher in the department, in order that the students may learn proper habits of study and may acquire a true conception of the character and scope of their future profession and of professional ethics and ideals.

Mr. Shaw's criticism of the lack of training of engineering teachers in pedagogy, education, etc., is largely true. Prof. C. R. Mann, of the University of Chicago, who is making an investigation of engineering education for the Carnegie Foundation for the Advancement of Teaching, stated about a year ago that as a result of a questionnaire which he sent to engineering teachers throughout the country he found that a large proportion of those who replied did not even understand simple educational terms. Most engineering instructors come into the teaching profession directly after graduation or after a somewhat limited practical experience. As regards the selection of teachers to fill the more responsible positions in technical schools, the writer quotes again from the address mentioned above:

> How often is an instructor selected because he is a clear, forceful, inspiring teacher? Is not usually more stress laid upon the number of academic degrees or his reputation as a profound scholar or professional expert? The great need of the whole teaching profession today is more teachers of real ability, strong personality and intellectual enthusiasm.

Mr. Shaws suggestion that a post-graduate course for engineering teachers be established is excellent and is one that the writer has had in mind for several years. The following quotation from the above-mentioned address will give a brief idea of the writer's view on this subject:

> The speaker believes that there is an opportunity for a few schools to offer an advanced course in engineering instruction. The purpose of such a course would be the training of teachers for our technical schools. The majority of the teachers in these schools today have come directly into the profession from the technical school or from practice and have little knowledge or understanding of the principles of pedagogy and education. The standards of engineering instruction would doubtless be raised if the teachers were required to have a special training which would be comparable to that required for teachers in the highest rank of the common schools of this country.

The writer hopes that Mr. Shaw's paper may lead to a wide discussion of this most important subject of engineering education.

A. B. McDANIEL.

Union University, Schenectady, N. Y., Feb. 9, 1917.

Removing Boric Acid from Volcanic Steam at Lardarelo, Italy

Sir—Referring to your interesting article on the volcano in Italy, which develops 15,000 hp., in "Engineering News" of Dec. 28, allow me to say that I visited Lardarelo, the site of this plant, some years ago and saw the boric-acid works originally established by an ancestor of the present Count.

All of the district now covered by the works was originally owned by the people of the neighboring ancient town of Monte Cerboli, but having been held by them as of little value, it was very cheaply obtained in 1818 by a poor young Frenchman (grandfather of the present Count Lardarelo), who detected the presence of boric acid in the steam and who was shrewd enough to appreciate the value of his discovery.

The boric acid to the extent of 0.1% is contained in the native steam that issues from the earth through numerous orifices, all of which have been tubed to a greater or less degree. These tubings are mostly of 8-in. pipe, and extend into the earth varying distances, some a few feet and others over three hundred. Certain of the fumaroles are entirely artificial, having been bored like artesian wells. The boring tool, when it reaches the steam zone, usually drops suddenly a yard or more, and immediately thereafter steam escapes with much force. The temperature of the issuing steam varies in the different outlets from 98 to 140° C., and it rushes from the pipes with great noise and power.

Ordinary spring water is led into a circular brick cistern about 30 ft. in diameter, and an 8-in. pipe, conducting natural steam, passes through the cistern wall about 1 ft. below the water surface. The issuing steam impregnates the water with boric acid.

After 24 hr. the solution is delivered to a square settling basin, where a grayish mud composed of exceedingly fine particles is precipitated, and the clear boric-acid water passes to lead evaporating pans (40 in number). These pans are 6 ft. wide by 150 ft. long by 8 in. deep. They are slightly inclined and are divided by small ridges 2½ in. high crossing them

transversely every 2 ft. The liquid enters at one end and slowly flows over the step-like divisions to the other, the rate of inflow being made equal to that of evaporation.

When in the judgment of the attendant the concentration has been carried far enough the flow is cut off and the hot, concentrated liquor is brushed out by brooms into crystallizing tanks, 10x30 ft. in size, and allowed to cool.

The deposited crystals of boric acid are removed by wooden scoops, drained in baskets, and the mother liquor is returned to the evaporating pans. The crystals are spread upon a steam-heated drying floor protected by a shed-like building 30x40 ft. in plan, and when dry are placed in bins for storage. The heating of the evaporating pans and drying floor—in short, heating of every description throughout the establishment—is by native steam.

The statement in our standard works of reference that "boric acid is recovered at both Monte Cerboli and at Lardarelo" is confusing, as they are practically one and the same place; and the dimensions given the artificial lagoons, "100 to 200 ft. in diameter," is a great exaggeration.

W. P. MASON.

Department of Chemistry, Rensselaer Polytechnic Institute, Troy, N. Y., Jan. 26, 1917.

Flood Gates in Levees

Sir—I notice in your issue of Jan. 11, in an article on a "Large Levee and Drainage System in Indiana," a paragraph indicating that flood gates will now be installed, with perhaps a pumping plant later. Some information concerning any system where flood gates have been successfully used for a length of time under trying conditions would be very interesting.

F. E. STAEBNER.

Fort Pierce, Fla., Jan. 20, 1917.

[This inquiry was referred to J. S. Spiker, engineer of the drainage system referred to, and he replies as follows.—Editor.]

Sir—Automatic flood gates such as we are using on the Brevoort levee have been in successful operation on the Wabash River at and near Vincennes for more than 30 years. My experience does not extend to any other stream. I have used them from 1 to 6½ ft. in diameter, but would not advise the use of gates more than 5½ ft. in diameter. When these circular flap gates are too large, they need as much attention as rectangular lift gates; and I make the division at 5½ ft.

The local conditions should govern the size that will work successfully, and great care should be exercised in placing the gate. It should be above the level of the accumulation of silt or fill near or at the gate, and also clear of débris or other light or floating matter that might accumulate in the culvert behind the gate. Two gates of the same size at different locations will vary in operation. We have practically closed in all the Brevoort levee work. The large flood opening at River Dushee is ready for the placing of the operating machinery.

J. S. SPIKER,
Consulting Civil and Sanitary Engineer.

Vincennes, Ind., Feb. 2, 1917.

Percolation Tests of Sewer Pipe

Sir—Permit me to answer the inquiry of G. E. P. Smith, as to the necessity of a percolation test of sewer pipe.

The percolation test for sewer pipe was, I believe, first used in Brooklyn, N. Y., for the reason that much of Brooklyn's sewage is pumped and any extra water to be handled by the pumps adds materially to the cost of operation. Many miles of this city's sewers are below ground-water level.

Kansas City, as a safety measure, copied this clause out of the Brooklyn specifications, although the topography of the city was not similar. The reason it is not used in Kansas City is because the specifications require an internal hydrostatic pressure test on both clay and cement pipe, and it was found that any pipe withstanding the pressure test would also stand the percolation test.

The difficulty with the percolation test is that it is not always specified in accordance with the use to which the pipe is to be put. There is little use in specifying a percolation test under high pressure unless the pipe is expected to work under pressure. It would be much more practical and more logical to substitute a density or porosity test. The American Society for Testing Materials has already acted along this line, and its latest specifications for drain tile (sewer specifications still incomplete) are designed, not to discover under what pressure the pipe will begin to leak, but what proportion of the pipe is voids, which is the important point.

The British Engineering Standards Committee previously reached similar conclusions and prescribed an absorption test for vitrified-clay pipe

Besides the absorption test the American Society for Testing Materials prescribes loading tests, chemical tests, freezing and thawing tests, but all these are written so as to meet, as nearly as possible, actual conditions of service. City engineers would therefore seem justified in recognizing the three principal reasons why sewer pipe should be as much pipe and as little holes as possible—namely, the sanitary reasons, the economic reasons and the structural reasons. The only error seems to be in copying, blindfold, the specifications from one city written to meet a special condition that does not exist in the others.

BENJAMIN BROOKS,
Engineer, International Clay Products Bureau.

Kansas City, Mo., Feb. 6, 1917.

[The Brooklyn specifications, according to Edwin J. Fort, Chief Engineer of the Bureau of Sewers, are rigidly enforced, whenever the sewers are placed below groundwater level. The clauses covering these percolation tests and the regular absorption test are:

170. When subjected to an internal hydrostatic pressure of 10 lb. per sq.in. vitrified pipe shall show no percolation.

171. After having been thoroughly dried and then immersed in water for 24 hr., sample pieces of vitrified pipe about 10 sq.in. superficial area with all broken edges shall not absorb more than 5½% of their weight of water.—Editor.]

Is Compression Positive or Negative?

Sir—Permit me to join R. W. Stewart ("Engineering News," Feb. 8, p. 248) in asking for some solution of the problem involving plus or minus marks for compression. This point, while a small one, causes considerable confusion in engineering offices and will continue to do so until it is settled. Kidder, Ketchum and the Carnegie "Handbook," as well as other standard works, use plus for compression and minus for tension. As you say in comment, all draftsmen of 20 years ago used the same system. The use of a minus sign for compression is a present-day practice.

Personally I favor + for compression; wall pressure is +, and the change of material from brick to steel should not change the sign. The best argument in favor of the minus sign is that, used thus, it agrees with Hooke's law of deformation, which law plays a very small part in the great majority of structural designs. If any of the national engineering societies—preferably the American Society of Civil Engineers—would give this matter a half-hour's attention, I believe that engineers and schools would accept the verdict.

P. B. MAC COY.

Pittsburgh, Penn., Feb. 13, 1917.

NOTES AND QUERIES

Herbert C. Hoover—In the article on the work of Herbert C. Hoover, Chairman of the Belgian Relief Commission, in "Engineering News" of Feb. 1, it was stated that Mr. Hoover was a graduate in mining engineering from the University of California. Mr. George H. Herrold, of St. Paul, a classmate of Mr. Hoover's, informs us that Mr. Hoover graduated from Leland Stanford Jr. University, and his course of study was geology, as the university had at that time no course in mining engineering.

Cleaning Cement Wash from Brick—J. W. B., who is in charge of the construction of a power house, writes to inquire the best method of cleaning cement mortar off the upper part of the walls. These walls are faced with a tapestry brick made with mortar consisting of one part portland cement, one part hydrated lime and four parts river sand. The roof is of concrete, and heavy rains occurring just as the roof was completed washed a film of cement off the roof onto the upper part of the walls, considerably disfiguring them. Of several methods suggested for cleaning these walls, it is felt that wire brushes require a great amount of labor and might not be effective and that an acid wash might injure the walls. Has anyone had successful experience in doing work of this sort?

New York Garbage-Reduction Works Controversy—By an omission in copying at Albany, the last clause of the third finding of Deputy State Health Commissioner Linsly E. Williams in the matter of the location of garbage-reduction works for New York City on Staten Island was omitted in the report to Governor Whitman (see "Engineering News," Jan. 18, 1917, p. 125). The third finding, as stated in a revised copy filed with Governor Whitman, was as follows:

The operation of the proposed plant will disseminate objectionable odors at times and under certain atmospheric and operative conditions in the neighborhood of the proposed plant, including the Village of Linoleumville, the settlement known as Fresh Kills and other property located in that vicinity, and will thereby constitute a nuisance.

Effect of Excess Water in Concrete*

By Duff A. Abrams†

Experience has indicated about what proportions of cement and aggregate must be used to give concrete of the necessary resistance for a given purpose, but little attention has been given to the inter-relation of the effects of varying quantities of water on the resistance of the concrete. A thorough investigation of this subject is in progress at the Structural Materials Research Laboratory. These tests have shown the following relations to obtain:

1. With a certain aggregate of the same grading and sufficient water to produce a concrete of a given plasticity, the strength of the concrete, within the usual range of mixes, is proportional to the quantity of cement in a unit volume of concrete.

2. With a given aggregate and the same quantity of cement, the strength of the concrete is a maximum with the smallest quantity of water which can be used to produce a plastic mix; any increase in the quantity of water is accompanied by a very rapid falling off in the strength of the concrete.

3. With a given aggregate mixture, the same quantity of cement, and sufficient water to produce a concrete of definite plasticity, (a) the strength of the concrete increases with the "coarseness" of the aggregate up to a certain limit; (b) this limit of "coarseness" is higher for a larger quantity of cement and lower for a smaller quantity of cement; (c) the limit of "coarseness" of the aggregate which it is feasible to use varies slightly with the character of the material, being somewhat lower for a mixture of sand and crushed stone than for sand and well-rounded pebbles, and lower still for mixtures in which crushed stone or similar material is used as fine aggregate.

4. For given proportions of cement and aggregate the quantity of water required for a definite plasticity depends largely on the grading of the aggregate and to only a minor degree on the character of the material, shape of particles, etc.

5. For a given aggregate, the quantity of water required to give concrete of the same relative plasticity is directly proportional to the quantity of cement.

The tendency has been during recent years to use entirely too much water; in many instances the water used is 50 to 100% in excess of the quantity which gives the highest strength, resulting in concrete of not more than 25 to 50% the strength that should have been obtained with the same cement and aggregate and a proper quantity of water. While some sacrifice in strength is generally necessary in order to secure concrete which may be handled and placed at low cost, it is absurd to sacrifice 50 to 75% of the strength which is practically available in this way. While the injurious effect of excess water in concrete has been given little attention, a great deal of emphasis has been placed on the benefits to be derived from the use of coarse, well-graded aggregate.

The experimental work referred to above has already thrown much new light on this subject. We are forced to the conclusion that the chief advantages of well-graded and coarse aggregate as compared with poorly-graded aggregate comes from the fact that the concrete can be mixed to a workable plasticity with less water, and not to any inherent difference in the behavior of aggregate of different sizes. In other words, while coarse, well-graded aggregate is highly desirable, little or nothing is gained by using aggregates of the highest grade unless we take advantage of the fact that it can be mixed with correspondingly less water. This makes it apparent that many of the shortcomings of concrete made of fine or poorly-graded aggregate should be charged to the additional water required to mix the concrete.

It is as important that an upper limit be placed on the quantity of water as it is that a lower limit be placed on the quantity of cement in the batch. It would be just as consistent to specify the quantity of aggregate and water and leave the proportioning of the cement to the judgment of the mixer foreman, as to specify the quantity of cement and aggregate and leave the proportioning of the water to the mixer gang. Exactly the same effect is produced by the use of an excess of water as by a deficiency in cement; and it is more important now that special attention be given to the water in concrete, since the present methods give reasonable assurance that the proper quantity of cement is used.

All the benefits which may arise from using good cement, coarse, well-graded aggregates, thoroughly mixing the concrete, etc., are completely nullified if an excess of water is used in the mix.

"In mixing concrete use the least quantity of water that will produce a workable mix, then give the concrete as much water as possible after it has begun to harden," is the only safe rule to follow.

Probably the greatest improvement which can be made in our present methods of manufacturing concrete will come from a better understanding of the very injurious effect of excess water and a saner practice in proportioning this important element of the mix.

*From "Concrete Highway Magazine," January, 1917.

†Professor in Charge Structural Materials Research Laboratory, Lewis Institute, Chicago.

Concrete Pipe and Tile

The use of concrete sewer-pipe and drain-tile was discussed from different points of view at the annual meeting of the American Concrete Pipe Association, held at Chicago, Feb. 12-14. The new specifications of the American Society for Testing Materials were reviewed by Geo. P. Diekmann (Chief Chemist of the Northwestern States Portland Cement Co.), and his remarks developed considerable discussion, particularly as to the proper requirements for the absorption test. A special field for concrete drain-tile, apart from its direct competition with clay tile, was suggested by E. R. Woods, State Drainage Engineer of Wisconsin. Transportation from rail to site is a large item in cost, and there are many districts which need drainage but where a haul of 10 to 15 mi. would be involved. He suggested the design of small concrete-pipe plants which could be located in such districts for two or three years and then shifted to other districts. Further, he considered 5-in. pipe should be the minimum size, to the exclusion of the 4-in. pipe now used.

Tests of the supporting power of pipe in trenches were reviewed in a paper by W. J. Schlick (Iowa State College). The use of a light concrete bed appears to offer many advantages. It was pointed out that it is not safe to rely upon arching of the earth fill to relieve the load upon the pipe, as saturation may prevent any such arching. The use of large tile drains as a substitute for open ditches was discussed by C. D. Kinsman (Purdue University). The tile drains avoid the division of land by ditches, and it is thought that they will keep in better condition, while the cost of maintenance will be much lower. Tile as large as 36 in. is being used. Mr. Kinsman considered that this line of work is in its infancy and offers a large field for development.

G. F. Lillie (Platte Valley Cement Tile Co.), Fremont, Neb., was elected President.

News of the Engineering World

Work Started on New Double-Deck Bridge in Kansas City

Work has begun on the new Kansas City Terminal Railway bridge over the Kansas River and the High Line viaduct which was noted in *Engineering News* for Oct. 26, 1916, as one of the improvements contemplated in the 200-year franchise recently granted the Terminal Company by Kansas City, Kansas.

The bridge itself will be built on the two existing piers, originally designed for a two-track structure. A new west abutment will be constructed. The present single-track steel bridge, built on the south side of the piers, was moved last spring to the center of the piers and raised so that the new bridge can be erected around it without interfering with traffic. The new bridge will be a double-deck structure, with two tracks on each deck. It will have two 300-ft. truss spans 65 ft. deep between pins and one 132-ft. truss span 30 ft. deep. The trusses will be 32.5 ft. apart c. to c., providing a clearance of 28.5 ft. for the double track. The clearance from top of rail for each deck will be 23 ft. The end posts and top chord will be of high-carbon steel and the eye-bars of nickel steel, the balance of standard structural steel. The floors will be timbered and ballasted for the track.

The trusses were designed by the Terminal Company's own forces, George E. Tebbetts being Bridge Engineer and John V. Hanna, Chief Engineer. Cooper's E80 loading was used, allowing unit stresses 25% in excess of those usually allowed. Under this method, while the bridge may be considered as designed for Cooper's E60 and normal unit stresses, any future increase in loading will find the details and connections equally as strong or with as large a factor of safety as the members themselves. On account of the ballasted floor, only 75% of the regular impact formula was used.

The upper deck of the bridge will be connected with the new double track High Line viaduct. This will extend to the east approximately 2700 ft. and with 1000 ft. approach between concrete retaining walls. On the west end, the viaduct will branch about 2075 ft. from the bridge, one branch extending north 7100 ft. and with 2000 ft. of approach between concrete retaining walls, the other due west 6500 ft. The viaduct will be the ordinary deck girder double-track construction except for three truss spans over railroad tracks of 117, 135, and 147 ft. span. The girders will have spans of from 50 to 60 ft. and all the steel portion of the High Line will have a concrete floor and ballasted track. The total length of the steel viaduct will be about 7700 ft. and there will be 12,000 ft. of graded approaches (a large part of which will be between concrete retaining walls) to connect with the surface main lines. The east approach will end close to the Union Station in Kansas City, Mo. The north branch of the west approach will end about 2200 ft. north of Central Ave.; the west branch of the west approach will end about Twelfth St. The High Line will therefore be used primarily for passenger train traffic, which will be taken up out of the congested switching and industrial track traffic, while the lower deck of the Kaw bridge will be used by freight traffic.

The Arkansas Bridge Company, of Kansas City, has been awarded the contract for the steelwork, and D. Munro & Co. the contract for a large portion of the concrete work. The whole improvement will cost close to $3,000,000. It will require nearly two years to complete.

Government Cement Specification

The United States Government has adopted for its standard specification for portland cement one in substantial accord with that adopted in 1916 by the American Society for Testing Materials, but varying from that specification in one important particular. The so-called "standard" specification has the following provision for fineness:

> The residue on a standard No. 200 sieve shall not exceed 22% by weight.

As a footnote to this clause the new government specification states that effective July 1, 1918, the government will demand a 20% residue requirement through the No. 200 sieve.

Boston Water Meter Controversy

The Mayor of Boston has decided to adopt the recommendations of the Boston Finance Commission to petition the legislature for a suspension of that provision of the laws creating the Metropolitan Water District, which requires the annual installation of meters on 5% of all old services and on all new services. In this connection the report of the Finance Commission states:

> It is the consensus of opinion among engineers that the essential object to be gained by water meters in the City of Boston has already been secured. The more important services have been metered and the meters in future will be installed in suburban districts where the use of water is below the average.
>
> There is ample expert authority for the prediction that the daily consumption of water per capita in the City of Boston will not fall below 100 gal. per capita. The consumption for 1915 appears to have been 104 gal. per capita. It is probable that any reduction per capita in water consumption in the future will be due to increased congestion of population, weather conditions, better pipe laying as regards the mains, the prevention of waste at faucets, and similar causes, rather than from the use of meters.
>
> The Finance Commission believes that at the present time a sufficient saving will not be made by the installation of meters at the prices demanded by the manufacturers to be commensurate with the expense involved.

The Finance Commission report also criticises the Supply Department of the city for not purchasing more meters while prices were low, although a provision of the city charter and a provision of the state law already referred to would seem to prohibit the purchase of more meters in any one year than the number to be installed during the year. It is recommended that the legislature be petitioned to repeal this provision.

A brief record of the rise in meter prices in Boston follows: From 1911 to 1914, inclusive, the Hersey Manufacturing Co. was awarded contracts for ⅝-in. meters at \$5 each. In 1915 Henry R. Worthington received the contract at \$4.95. In 1916 bids were opened on Mar. 6 for 5500 meters, ⅝-in. size, with an option of increasing or reducing the quantity by 30%. The prices were: Hersey Manufacturing Co., \$5.55; Henry R. Worthington, \$5.90; Thomson Meter Co., \$8.40 and the Pittsburgh Meter Co., \$6.66. The only bid for the 1917 supply—5500 meters of ⅝-in. size—opened Dec. 26, 1916, was that of the Hersey Manufacturing Co. of \$8.10. This bid was rejected and new bids were asked, which were opened Jan. 9, 1917. These bids were: Hersey Manufacturing Co., \$8.10; Union Water Meter Co., \$8.10; Thomson Meter Co., \$8.60; Buffalo Meter Co., \$9.40; Pittsburgh Meter Co., \$11.50. These bids have also been rejected.

In investigating this increase of prices, the Finance Commission interviewed James A. Tilden, General Manager of the Hersey Manufacturing Co., and reports as follows:

> There has been formed, with headquarters in the City of New York, the Meter Manufacturers' Exchange, comprising eight of the ten companies manufacturing water meters in the United States. The Gamon Meter Co., of Newark, N. J., and the Badger Meter Co., of Milwaukee, Wis., are the two companies which are not members of the exchange. Mr. Tilden stated that he is the president and that there is a permanent secretary.
>
> The Commission has no evidence that the Meter Manufacturers' Association is used as an opportunity for water meter manufacturers to raise prices by collusion in their bidding, or that such acts have been attempted. It does believe, however, that associations of this kind offer an excellent means for such collusion and their existence is a potential danger to open competition.

Jersey City Water-Supply Contest Suit May Be Reopened

What promises to be a most interesting occurrence in the litigation branch of water-supply and sewage-pollution sanitation is the recent determination of the City Commission of Jersey City to open up the old suit brought by that municipality against the Jersey City Water-Supply Co. to compel the latter to construct a trunk sewer to divert the sewage of Dover, Boonton and other municipalities below the Boonton dam and reservoir of the Jersey City water-supply.

When Jersey City contracted some years ago for a new gravity water-supply from the Rockaway River, there was inserted in the contract a provision that the contractor must deliver pure and wholesome water. Rightly or wrongly, the people both of Jersey City and in the Rockaway River drainage area above the site of the proposed dam got the idea that the contractor would build a trunk sewer to carry the sewage of the various municipalities along the course of the river to a point below the proposed reservoir. Instead of doing this, the Jersey City Water-Supply Co. installed the first large hypochlorite disinfection plant, and one of the very earliest of the kind large or small, at the Boonton dam, claiming that this plant fulfilled the contract requirements as to providing pure and wholesome water. A battle royal in the courts followed, with the result that the contractor won the suit. The court held on the strength of the evidence submitted that hypochlorite disinfection of water was a sufficient safeguard to fulfill the contract requirements mentioned. The testimony and decision, it should be noted for the benefit of those not informed, was handed down very early in the history of hypochlorite disinfection.

After the decision was rendered, there were negotiations between Jersey City and the municipalities in the Rockaway River drainage area looking to the construction of a trunk sewer at joint expense. A consummation of the negotiations seems to have been prevented by unwillingness on the part of one or more of the municipalities on the drainage area. Subsequently, Jersey City changed to the commission form of government. After numerous conferences between the representatives of Jersey City, the municipalities in the drainage area and the State Department of Health, it was finally made clear that Jersey City was determined not to pay any part of the cost of a trunk sewer and was trying to get the State Department of Health to force the municipalities in the drainage area to bear the whole responsibility and expense of any measure necessary to protect the water-supply.

When this became evident the State Department of Health forthwith notified the authorities of Jersey City to show cause why they should not be directed to prepare plans and submit them within two months for an uptodate water-purification plant. About the same time Dover submitted to the State Department of Health plans for a sewage-treatment plant, the effluent from which would be discharged into the Rockaway River above the Boonton reservoir. A sharp division of opinion arose in the State Department of Health as to the various questions involved in the Jersey City water-supply situation. An attempt was made to secure the adoption of a general policy that would serve as a guide not only in this but in other cases throughout the state involving relations between sewage pollution and public water-supplies. It does not appear that the department has ever taken final action in the matter.

The latest reported move along any definite line is the action of the Jersey City Commission already mentioned. Under the terms of this action Corporation Counsel John Milton will apply for a reopening of the old lawsuit against the Jersey City Water-Supply Co. on the ground that the court was misled (although not wilfully) into the belief that hypochlorite disinfection was an adequate substitute for the diversion of the sewage of the various municipalities to a point below the reservoir.

Finally, it may be noted that all the municipalities in the Rockaway drainage area above the Boonton dam are as yet practically without sewerage systems, so that such pollution as is reaching the water-supply comes for the most part from individual buildings.

Fire in Flooring of McKinley Bridge

Fire was discovered in the wood flooring of the McKinley Bridge of the Illinois Traction Co., over the Mississippi River at St. Louis, at 6 p.m. on Feb. 15. This bridge was built principally for interurban car service, in 1910, and once before its flooring was on fire.

The bridge is a single-deck structure, carrying double tracks between the trusses, and has a roadway about 12 ft. wide cantilevered on each side. The cantilever construction consists of brackets at the main panel-points, which are joined longitudinally at the outer and inner edges by light steel girders. These girders in turn carry a light

steel floorbeam at the center point, thus reducing the spacing to about 15 ft.

The floor construction consists of five 8x16-in. timber stringers, one end resting on the bracket and the other on the center beam. The floor itself is made up of slats 1x2½ in. by 4 ft. long joined together to form sections 20 in. wide by 4 ft. long by 3½ in. deep, and held together by three bolts running through the 20-in. width. As laid in the bridge there are three sections to the width of the roadway, so that each section rests on three stringers. The stringers are creosoted yellow pine, while the floor slats are of mixed hardwoods, largely oak. The floor slats are untreated but seem to have been dipped in pitch or some preservative before laying. The wear on the floor has been very severe and it is estimated that probably all of it has been replaced at least once since the bridge was opened. At the present time, much of it is badly broken and crevices between the slats are filled by dry manure and fine dust.

The origin of the fire is unknown, but is supposed to have been due to a live coal dropped from a tar-roofers' wagon; although the fire was practically confined under the floor, it is impossible that it could have been ignited from underneath.

Several hundred feet of the north roadway was affected by the fire, much of the flooring being ruined and a large proportion of the timber stringers badly charred, particularly at the ends. In addition to this, the two longitudinal steel girders at the edges of the roadway were overheated. Many of them are warped and several broken through. There seems to be little damage to the cantilever brackets and none to the main trusses. The total damage will probably not exceed $15,000.

The American Association of Engineers Meets Membership Problem

The young and radical American Association of Engineers has begun to face the problem of qualifications for membership like the old-established societies. Where the qualifications approach the minimum of the requirements, it is found to be a difficult matter to pass judgment on the individual cases. At the recent Chicago convention N. M. Stineman (Office Engineer, Chicago, Milwaukee & St. Paul Ry.), who is chairman of the committee on qualifications, discussed the subject in detail.

The constitution of the association states that a certified member shall be a graduate of an engineering school of good standing, and in addition he shall have had two years of engineering experience. The committee took the position that "engineering experience means nothing less than the solving of engineering problems." Tracers and rodmen, for instance, are not called upon to solve engineering problems; consequently, their work cannot be classed as experience in engineering.

Applicants who have not graduated from technical schools may be admitted to certified membership after they have had at least five years of experience in engineering.

Again, what is meant by experience? Taking as his example the case of a young man who enters an engineering office and spends perhaps several years in tracing, Mr. Stineman holds that this apprenticeship portion of his work cannot be classed as experience in engineering. What weight should be given to school training of various kinds is another question that has given trouble. The committee answers him as follows:

The committee finds it extremely difficult to give proper weight to the education of many of the applicants. If the membership were confined to graduates of technical schools, the work would be greatly simplified, for it would then be provided with a definite starting point. However, many men obtain an engineering education through special or partial courses in engineering institutions, through technical high schools, night schools and correspondence schools. The committee wishes to give recognition to men who by their persistency and native ability have succeeded in getting a technical training through some such manner, but such recognition should not be carried to the point of absurdity.

We should not lose sight of the worthiness of many men who, with no financial resources aside from their own savings, have denied themselves everything else in order to win a thorough college training. Surely they are quite as worthy of our consideration as are the men who have taken a shorter, easier and less thorough road to engineering. Consequently, an applicant who has spent but a few months in an engineering institution will not be considered as having completed a "partial course" in that institution; not all so-called technical high schools are such in reality; night-school work cannot be recognized unless the studies were pursued through a considerable length of time; and uncompleted courses in correspondence schools cannot be considered.

Recognizing the obvious fact that a minimum educational qualification must be established somewhere, the committee will not grant membership of any grade to a man who is not a technical graduate, unless he is a graduate of a high school or of an academy or other school with a course of study similar and equal to that of a high school.

Licensing Architects in Indiana by means of a State Board of Architects has been defeated, 51 to 36, in the lower house of the Legislature.

Building in Canada was much more active in 1916 than in 1915, which was a very slack year. The new structures are partly due to demands of war industries and partly to the establishment of Canadian branches of American manufacturing corporations.

Ten Coal Cars and an Engine Were Seized on the Pennsylvania R.R. in Cleveland, Ohio, on Feb. 10, by a police squad under the direction of T. S. Farrell, Director of Public Utilities. The municipal water and electric stations had only a few days' supply and the City could not secure deliveries of its own fuel.

Teamsters Must Inspect Bridges in Kansas—A teamster whose wagon broke through a bridge floor in Kansas sued for damages, but when his case came to trial, recently, it was thrown out of court. An old Kansas law provides that when a teamster with a heavy load reaches a bridge he must examine it before driving on it, and if necessary lay planks for his wheels. This teamster had failed to follow the law.

Further Progress on the East River Tunnels was recorded by completion of the headings in the Brooklyn approach to the Whitehall-Montague St. tunnel. The south tunnel was holed through to the shaft at Clinton and Montague St. on Jan. 30, and the north tunnel a few days later. These land tunnels were started at Willoughby St. and Flatbush Ave. Extension on Mar. 10, 1915. Shields were used, without compressed air, the sand being dry.

A Steamship and Warehouse Terminal in the southern part of San Francisco is planned by the Southern Pacific Co. It is proposed to widen the Islais Creek channel to 300 ft. and deepen it to accommodate vessels of 35-ft. draft. Warehouses would be constructed adjacent to the slip, and the total investment contemplated is about $10,000,000. Plans for the work have been made by Howard C. Holmes, Chief Engineer of the San Francisco Dry Dock Co.

Electrification of the Lehigh Valley R.R. is under consideration, and engineers are now making surveys and investigations preparatory to rendering a report upon the project. The Lehigh Valley carries a very heavy coal traffic from the anthracite region to tidewater, and all trains have to climb over a high summit in passing west from Wilkes-Barre. It is stated that the plans for electrification comprehend the entire main line from Jersey City to Wilkes-Barre.

A Broken Water Main in Brookline, Mass., tore up a sidewalk, blocked electric cars and flooded cellars on Feb. 14, at 6:45 a.m. The main, 30 in. in diameter, was laid by the City of Boston in 1848 and carried a normal pressure of 44 lb. per sq.in. The street covering was asphalt on a concrete base and was strong enough to force the water to one side, where it

broke through the brick sidewalk. A sewer was recently laid under the sidewalk, not many feet from the water main, and W. E. Foss, Chief Engineer of the Metropolitan Water Board, stated that possibly the main broke because of ground subsidence.

The February Blizzards in Wyoming are the worst in many years, according to press dispatches. The experience of one of the trains (Overland Limited) of the Union Pacific R.R. is detailed. The train left Laramie behind a rotary snowplow pushed by five locomotives, but was nevertheless stalled at Rock River. The snowdrifts were bucked until the plow was broken. Thirteen trains were in line at Rock River at one time on the westbound track, while about 15 eastbound trains were held up in the vicinity. When the train was first stalled, the temperature was 47° below zero, unofficial reports state. The Overland Limited reached San Francisco 79 hr. late.

A City-Manager Charter for Kansas City, Mo., will go to popular vote on Mar. 6. An administrative board of ten members and mayor, elected at large, would fix the general policy of the city and appoint a city manager who would, in turn, appoint the heads of the various departments and conduct the business affairs of the city. The proposed charter provides for the initiative, referendum and recall on moderate petition percentages. It also simplifies public improvement proceedings, provides for payment of contractors in cash and reduces the interest on tax bills from 7 to 6%. The engineer plays a prominent part throughout, the city engineer being deputy city manager. A campaign has been inaugurated and meetings of information are being held.

PERSONALS

C. M. Thompson has been appointed Division Engineer of the Union Pacific R.R. at Denver, Colo.

Joseph F. McGuire, County Surveyor of Johnson County, Missouri, has been appointed County Highway Engineer.

F. L. Manning has been made General Manager of the Peebles Paving Brick Co., Portsmouth, Ohio, succeeding S. C. Peebles, resigned.

George Smart, Editor of the "Iron Trade Review," Cleveland, Ohio, has resigned to join the editorial staff of the "Iron Age," New York City.

Leo J. Byrne, County Surveyor of Meigs County, Ohio, has been appointed City Engineer of Pomeroy, Ohio, succeeding E. G. Campbell, resigned.

C. M. Garland has been placed in charge of the new power department of the Allen & Garcia Co., consulting and constructing engineers, Chicago.

Alva O. Greist announces that he has opened offices at 51 East 42d St., New York City, as Consulting Engineer, specializing in public utility properties.

Edward W. Dahl, formerly County Engineer of Yuma County, Arizona, has been appointed City Engineer of Yuma, Ariz., succeeding W. H. Elliott, resigned.

R. S. Durrell has resigned as Assistant Engineer of the Ohio State Board of Health, Columbus, Ohio, to accept a position with the Sewer Pipe Manufacturers' Association, Akron, Ohio.

W. H. Wood has been appointed County Highway Engineer of Vernon County, Missouri, at an annual salary of $1000 per annum. He is also County Surveyor, which is an elective office.

H. De H. Connick, M. Am. Soc. C. E., former Director of Works of the Panama-Pacific Exposition, San Francisco, Calif., is now with the American International Corporation, New York City.

D. C. Moon, General Manager of the New York Central Lines West of Buffalo, has been appointed Assistant to the Vice-President in charge of operation. His headquarters for the present will remain at Cleveland, Ohio.

C. E. Johnston, M. Am. Soc. C. E., Chief Engineer of the Kansas City Southern Ry., has been promoted to be General Manager. This is a new position, the duties of which have hitherto been divided among the vice-presidents.

C. Gore-Langton, recently Designing Draftsman, Chief Engineer's office, Atchison, Topeka & Santa Fe Ry., Western Lines, Amarillo, Tex., is now in charge of design and erection of a new unit of the Natural Soda Products Co., Keeler, Calif.

Walter Braun, County Engineer, **Joseph H. Fleming** and **E. P. Knollman,** of the County Engineer's office, Franklin County, Columbus, Ohio, have formed the engineering and surveying firm of Braun, Fleming & Knollman, with offices in Columbus.

W. A. Williams, M. Am. Inst. M. E., Chief Petroleum Engineer, United States Bureau of Mines, with headquarters in San Francisco, Calif., has resigned to become Assistant to the General Manager of the Empire Fuel & Gas Co., Bartlesville, Okla.

Raymond Matthew, for the past year head of the Department of Irrigating Engineering, New Mexico College of Agriculture and Mechanic Arts, has resigned to become Assistant Engineer for Charles H. Lee, Consulting Engineer, Los Angeles, Calif.

W. A. Hey, formerly of the Miller-Hey Co., contractors, Waterloo, Iowa, and **B. H. Keeler,** for the past 10 years superintendent and Chief Engineer of the Crane Construction Co., Kansas City, Mo., have organized the Hey-Keeler Construction Co., Black Hawk Bldg., Waterloo, Iowa.

Dwight D. Miller has joined the staff of the Society for Electrical Development, New York City. He is a graduate of Harvard University. He was for over ten years with the Westinghouse Electric and Manufacturing Co. as Sales Engineer. He has been Sales Manager and Consulting Engineer for two other firms handling electrical and mechanical apparatus.

A. S. Ingalls, Assistant General Manager of the New York Central Lines West of Buffalo, has been promoted to be General Manager, succeeding D. C. Moon, promoted, as noted elsewhere. Mr. Ingalls is a graduate of Harvard University and entered the railway service as a clerk in the office of the General Manager of the Cleveland, Cincinnati, Chicago & St. Louis R.R.

Erle T. King, Assoc. M. Am. Soc. C. E., recently Assistant Engineer with Lederle and Provost, Consulting Sanitary Engineers, New York City, and for 10 years Assistant Engineer with the Board of Water Supply of the City of New York on Catskill Aqueduct work, has been appointed Assistant Secretary of the General Contractors' Association, 51 Chambers St., New York City.

Fred C. Jackson, a civil engineer on the Hudson Bay Ry. in Canada, is the discoverer of the Flin-Flon Lake copper district 650 mi. northwest of Winnipeg, Man. He had never been on a prospecting expedition before October, 1915, when he staked out the present Mandy claim. The Tonopah Mining Co. of Nevada bought the claim of Mr. Jackson, agreeing to develop it and give the original finder a 15% interest. There is nearly $15,000,000 in chalcopyrite ore in sight, according to the "Engineering and Mining Journal."

OBITUARY

Robert L. Leonard, a prominent levee contractor of Memphis, Tenn., was recently killed in a railway wreck at Mounds, Ark.

Willard D. Johnson, a former Topographer of the United States Geological Survey, Washington, D. C., committed suicide Feb. 13.

Dr. Henry Dwight Holton, Secretary of the Vermont State Board of Health for many years, died at his home in Brattleboro, Feb. 12, aged 78 years. He was a Past-President of the American Public Health Association.

William Lyon Mackenzie, M. Can. Soc. C. E., Bridge Engineer of the Canadian Northern Ry., died at his home in Winnipeg, Man., Feb. 8, aged 57 years. His early engineering experience was with the Canadian Pacific and Grand Trunk railways. For the past 12 years he had been Bridge Engineer of the Canadian Northern Lines West of Lake Superior.

William O. Henderer, M. Am. Soc. C. E., President of the Osborn Engineering Co., Cleveland, Ohio, died in Florida, Feb. 8, aged 50 years. He was born in Castleton, N. Y., and went to Cleveland in 1893, when he became associated with F. C. Osborn. He was elected Vice-President of the Osborn Engineering Co. in 1900 and President in 1910. He was a Past-President of the Cleveland Engineering Society.

J. G. Macklin, M. Can. Soc. C. E., for many years Engineer of the Midland division of the Grand Trunk Ry., at Peterborough, Ont., died in England, Feb. 5. He was born in England and went to Canada as a young man and his first engineering experience there was on the construction of the cantilever bridge over Niagara River, below the Falls. His last important engineering work was the planning and construction of the dam on the Richelieu River at Chambly, Que. He is survived by a son, Lieut. F. C. A. Macklin, of the Royal Engineers.

Philip F. Kennedy, Superintendent of Construction of the Post St. reinforced-concrete arch bridge, Spokane, Wash.,

which collapsed Feb. 6, was drowned Jan. 29 by falling from the falsework of the bridge. He was a graduate of the Massachusetts Institute of Technology, class of 1907, and for several years was Assistant Engineer in the office of the City Engineer of Spokane. When the contract for the new Post St. bridge was awarded to Olson & Johnson, of Missoula, Mont., the contractors employed Mr. Kennedy as Superintendent in charge. He is survived by a widow and twin sons, about 4 years old.

John Stocks, a member of the Alberta Public Utilities Commission and for many years Deputy Minister of Public Works of the Province, died Feb. 9 at his home in Edmonton, Alta. He was born in Sherrington, Que., in 1858. He joined the engineering forces which were building the Canadian Pacific Ry. in 1881. He remained with the engineer corps of this railway for 20 years. In 1901 he was appointed Assistant Chief Engineer of the Northwest Territories and in 1905 was made Deputy Minister of Public Works of Alberta. This office he held for 10 years, when he became a member of the Provincial Public Utilities Commission.

Howard A. Greene, Assoc. M. Am. Soc. C. E., Division Manager of Erection, American Bridge Co., Pittsburgh, Penn., died on Feb. 2 of pneumonia. He was born at Providence, R. I., on Sept. 15, 1860, and was a graduate of Brown University. After graduation he was engaged in construction work in various parts of the country. At the time of the formation of the American Bridge Co., he was in charge of erection in the New York district for the New Jersey Steel and Iron Co., having been in the employ of this company since 1891. In July, 1901, he was appointed Erection Manager of the Pittsburgh division of the American Bridge Co., which position he held until the time of his death. While serving in this capacity he was in charge of the erection of many important structures, and was also the inventor of a number of important erection devices that are patented. He is survived by a widow.

Eugene C. Lewis, M. Am. Soc. C. E., Chairman of the Board of Directors of the Nashville, Chattanooga & St. Louis Ry., died Feb. 13 at his home in Nashville, Tenn. He was born in Stewart County, Tennessee, June 22, 1845. His father was owner and operator of a large iron-smelting plant, and here he gained his first technical knowledge and experience. He was graduated from Chester Military Academy in Pennsylvania in 1865. His first civil engineering experience was on a railroad survey in Arkansas. Subsequently he was with the engineer corps of the Louisville & Nashville R.R. He was one of the contractors on the Cincinnati, New Orleans & Texas Pacific Ry. Following the completion of this work Major Lewis was Sales Manager and later General Manager of the Sycamore mills of the Du Pont Powder Co. He was an officer of several Tennessee companies. In 1910 he was elected Chairman of the Board of Directors of the Nashville, Chattanooga & St. Louis Ry., having previously served this company as President and General Manager of the Nashville Terminals and as President of the railway. He was General Director of the Tennessee Centennial Exposition in 1897. He was a charter member of the Engineering Association of the South and its President in 1893. He was elected a member of the American Society of Civil Engineers in 1873 and served two terms as a Director.

ENGINEERING SOCIETIES

AMERICAN CERAMIC SOCIETY.
Mar. 5-8. Annual meeting in New York City. Secy., Edward Orton, Jr., Columbus, Ohio.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Mar. 5-10. Annual meeting in New York City at McAlpin Hotel. Secy., T. A. Randall, Indianapolis.

CENTRAL ELECTRIC RAILWAY ASSOCIATION.
Mar. 8-9. Annual meeting in Indianapolis. Secy., A. L. Neereamer, Indianapolis.

NEW ENGLAND RAILROAD CLUB.
Mar. 13-17. Annual meeting in Boston. Secy., W. E. Cade, 683 Atlantic Ave., Boston.

WISCONSIN ELECTRICAL ASSOCIATION.
Mar. 15-16. Convention in Milwaukee. Secy., George Allison, First National Bank Building, Milwaukee.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 20. Annual meeting in Chicago at Coliseum. Secy., C. W. Kelly, Kelly-Derby Co., Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 21-22. Annual meeting in Chicago. Secy., Horace H. Clark, 1325 Edison Building, Chicago.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 20-22. Annual meeting. Congress Hotel, Chicago. Secy., E. H. Fritch, 900 South Michigan Ave., Chicago.

The American Institute of Consulting Engineers has elected to the Council the following: A. M. Hunt, Lewis B. Stillwell, Wm. J. Wilgus, Gardiner S. Williams.

The Association of American Steel Manufacturers held its annual meeting in Pittsburgh on Feb. 20 at the William Penn Hotel. The secretary is Frank A. Robinson, Steelton, Penn.

The Second Annual Drainage Conference of the University of Illinois is to be held Mar. 13 to 15. The discussions will include the organization and financing of drainage districts, the surveying of drainage areas, design of systems and improved methods of construction.

The Albany Society of Civil Engineers at its annual meeting on Jan. 23 elected the following officers: President, Edward H. Sargent; vice-presidents, Ervin B. Stevenson, Austin C. Harper, Ernest G. Raynor; treasurer, Oliver W. Hartwell; secretary, Edwin S. Cullings.

American Society for Testing Materials—The annual meeting will be held as usual at Atlantic City, June 26-30, 1917. In reaching its decision as to the place and dates for the next annual meeting, the Executive Committee had for its guidance the returns from its invitation of last November to the membership at large for suggestions in that connection, which may be summarized as follows: Total number of returns, 453; favoring Atlantic City, 256; Chicago, 56; New York, 42; Washington, 18; Pittsburgh, 17; scattering, 64. As to time, 276 members favored June, of whom 175 favored the last week in June.

The Iowa Engineering Society is holding its 29th annual meeting at the present time at Ames, Iowa. In Wednesday's proceedings was a paper by C. H. Young, City Engineer of Muscatine, on "Numbering Houses and Naming Streets." In the evening following a talk on the commission-management plan of city government, by O. E. Klingaman, what is known as a first annual "Camp Fire" was held, the same being an informal hour for stories and reminiscences. This morning's session was given over entirely to business. In the evening an informal banquet will be held at the Sheldon-Munn hotel. On Friday morning the new filtration plant at the engineering experiment station of the Iowa State University will be inspected.

The American Association of Engineers scheduled a three-day meeting Feb. 8 to 10, but some of the proposed sessions were not held and the principal features were centered in an afternoon meeting on Feb. 10. The subject of engineering ethics, as a control or guide in the personal and professional activities of the engineer, and in relation to his position before the public, was presented interestingly by Prof. F. H. Newell (University of Illinois). In a paper on "Civil Service and the Engineer," by Garrison Babcock, it was stated that the civil-service system is closer to the engineering profession than is any other arm of the Government. It represents scientific principles in public enterprises and is the channel through which good engineering must enter public service. The paper was discussed by William B. Hale, of the Chicago Civil Service Reform Association. The problem of minimum qualifications for membership, which has become increasingly insistent with the growth of the association, was reviewed by N. M. Stineman (Chicago, Milwaukee & St. Paul Ry.). An abstract of this paper appears elsewhere in this issue.

The Minnesota Surveyors and Engineers Society held its twenty-second convention at Minneapolis, Feb. 7 to 9. The Engineers' Club of Minneapolis provided the social features. The Civil Engineers' Society of St. Paul held a joint meeting with the Minnesota Society on the afternoon of Feb. 8, and the Minnesota Joint Engineering Board held its annual meeting at the same time and place. This board was organized about a year ago as a coöperative movement, its membership consisting of one member from each of the chapters of the national societies and from each of the local societies in the state, and this was its first annual meeting. The Minnesota Society committee reports on drainage and sanitation attracted attention, due to pending state legislation which would place all drainage matters under a bureau of drainage, whose head would be a civil engineer reporting to a Director of Public Domain, and which would reorganize the state board of health, reducing the number of members from nine to five and placing considerable power in the hands of a director (not necessarily a doctor). The subjects and authors of some of the technical papers were: "Third Avenue Bridge, Minneapolis," by F. W. Capellen, city engineer; "Minneapolis Industrial District" (ideal industrial sites, with trackage), by L. H. Brittin, general manager; "Designing the Largest Locomotive Crane," by Gordon Beulke, American Hoist and Derrick Co., St. Paul; "Water-Service Connections," by Garrett O. House, superintendent, Water Department, St. Paul; "Development of Water Power at Minneapolis," by R. D. Thomas, engineer, St. Anthony Water Power Co. The officers elected for the ensuing year are: John Wilson, President, Duluth; C. H. West, Vice-President, St. Cloud; T. D. Sterling, Secretary, St. Paul; W. F. Rosenwald, Treasurer, Madison.

Appliances and Materials

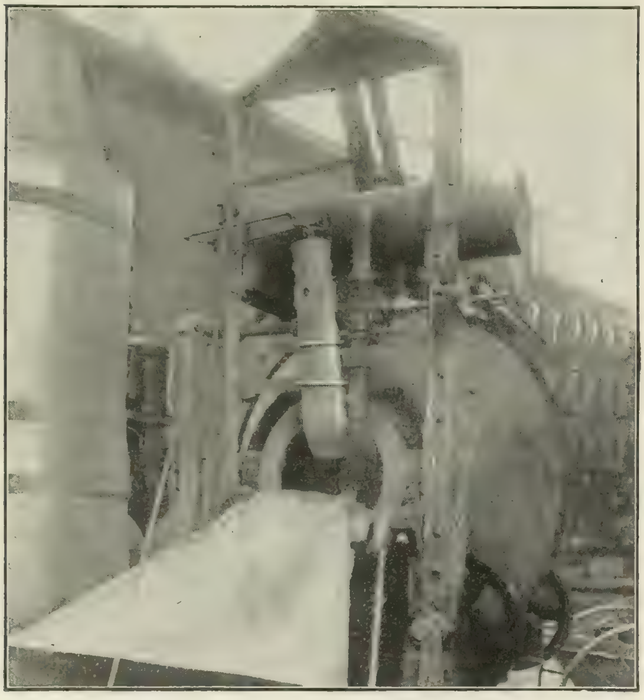
Automatic Temperature Controllers

A new line of automatic controllers for closely regulating the temperature of industrial furnaces (gas- or oil-fired or electric heated), etc., has been developed by the Bristol Co., of Waterbury, Conn. The new system comprises three elements: (1) The temperature-measuring instrument, which may be any one of the well-known types of Bristol pyrometers or thermometers; (2) the contactor, which is a newly patented circuit-closing device operated at predetermined maximum and minimum points by the pyrometer or thermometer mechanism with which it is combined; (3) the furnace regulator, which is either a pair of electrically operated air and gas valves or a relay switch for electric furnaces. These controllers are furnished for all work up to 3000° F.

* * *

Oil Burner Heats Concrete in the Drum

A device for heating concrete in the drum of a mixer by means of an oil burner is produced by the Hauck Manufacturing Co., 140 Livingston St., Brooklyn, N. Y. The purpose of this apparatus, which is attached to concrete mixers as shown in the view, is to make winter concreting possible so far as the mixing is concerned. There are two types, one hand-operated and one compressed-air operated. The hand type has a 20-gal. oil-storage tank equipped inside with a powerful hand pump. The tank can be placed on the operator's platform or on the ground, as preferred. The burner used with the hand-operated heater is of the vaporizing type, burning kerosene or coal oil, and it consumes approximately 2 gal. per hr. An oil pressure must be carried of from 20 to 75 lb. A 25-gal. tank accompanies the compressed-air outfit; the



OIL BURNER ATTACHED TO CONCRETE MIXER

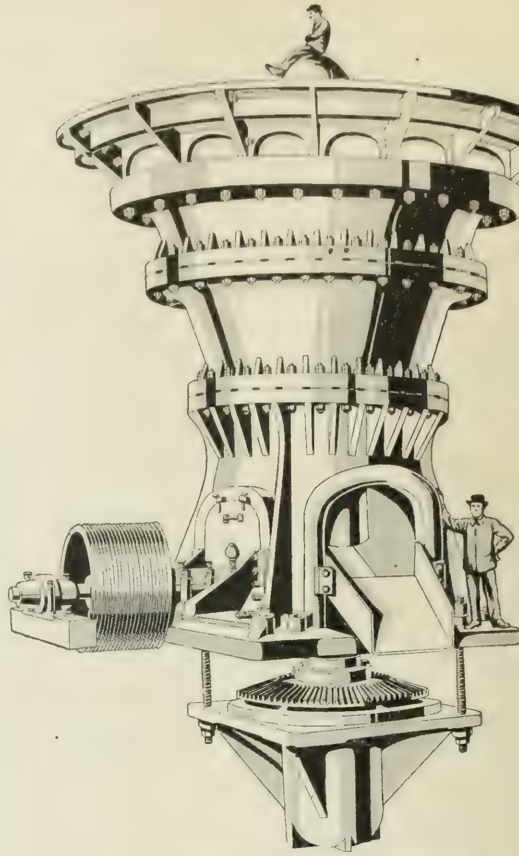
burner is of the atomizing type, requiring 15 ft. of free air per minute and burning about 1½ gal. of oil per hour. On both types the burner discharges to a steel pipe, made of oval section on the lower end so as not to interfere with the hopper. It has a short bend, so that the flame shoots diagonally into the drum.

* * *

Record-Breaking Gyratory Crusher

The world's largest rock crusher to date has been completed by the Kennedy-Van Saun Manufacturing and Engineering Corporation, of New York City, for the Michigan Limestone and Chemical Co., at Calcite, on Lake Huron, near Rogers City, Mich. The new machine will be used as a primary crusher, taking 60-in. stone and reducing to 8 in. and finer. It has a capacity for reducing 30,000 tons of limestone per 20-hour day. It is driven by a 300-hp. electric motor, through an English rope drive. The crushing space, between the head and concaves, holds 30 tons of stone. The hopper, which flares out above to a diameter of about 22 ft., affords added receiving capacity of 35 tons of stone.

The machine is 34 ft. high over all. The main shaft is 28 ft. long and 3 ft. in maximum diameter. The eccentric has a ball-and-socket bearing lined with a halved phosphor-bronze bushing on which the unit load is reduced to 175 lb. per sq.in.



HUGE NEW GYRATORY CRUSHER

The eccentric and eccentric-thrust-collar bearings are oil lubricated by a circulating pump.

The spider (a single two-arm casting) is set clear of the concaves, so that the latter can be reset without disturbing the head or spider. These concaves are made in four horizontal belts of sections to facilitate handling and so that, when worn, only those portions requiring replacement need be renewed. The top shell was too heavy to ship in one piece, so it was made in two horizontal sections with bolted, flanged, tapered, machined, male and female joints. The head is rigidly secured to the main shaft on its smooth tapered portion, being held in position by a sleeve nut fixed on, but not screwed to, the shaft. This nut operates in a follower zinked in the top of the head, so that the tendency of the head to rotate on the shaft locks the former on the latter. The mainshaft is suspended from the spider by a nut bearing on a sleeve and steel wearing ring. The head and concaves, which take the principal wear from crushing, are constructed of semisteel castings. The bevel gear and pinion are of cast steel, with planed teeth; the gear is keyed to the eccentric. The countershaft is equipped with an extra-long bearing, which is adjustable in respect to the frame of the crusher, so that by removing or inserting shims its vertical position may be regulated to adjust the gears. The bearing supporting the eccentric and gear is constructed with hardened and polished high-carbon steel wearing rings attached to the bottom plate and eccentric flange respectively, between which is a phosphor-bronze floating ring.

The stone is brought to the crusher by 8- to 10-car standard-gage trains. The broken stone from this crusher is spouted to a belt conveyor, which carries it on an upward incline to revolving screens, the rejections from which are fed to smaller crushers producing the finer sizes of stone required. It is then conveyed either to ground storage or to bins, from which it is loaded by shuttle conveyors onto specially built steamboats for transport on the Lakes to customers, principally large steel producers who utilize this limestone for furnace flux.

Engineering News

VOLUME 77 | MARCH 1, 1917 | NUMBER 9

Clamshell Dredge with 195-Ft. Boom

The clamshell dredges used extensively for levee work on California rivers have been notable for their long booms, which are necessary for building the levee at a sufficient distance from the deep-water channel. Lengths of 120 to 125 ft. were in use more than 10 yr. ago. A dredge with 175-ft. boom was built in 1907 by the Risdon Iron Works, of San Francisco. It handled a 5-yd. bucket and could lift a weight of 18 tons at 175-ft. reach. Its hull was of timber construction, 130x61½ ft., with a depth of 12 ft. This machine was burned in 1911, but the available parts of the equipment were utilized in the new and larger dredge described below. This was built by the Union Works Co., of San Francisco, Calif., and information has been furnished by George L. Hurst, Manager of the Dredging Department.

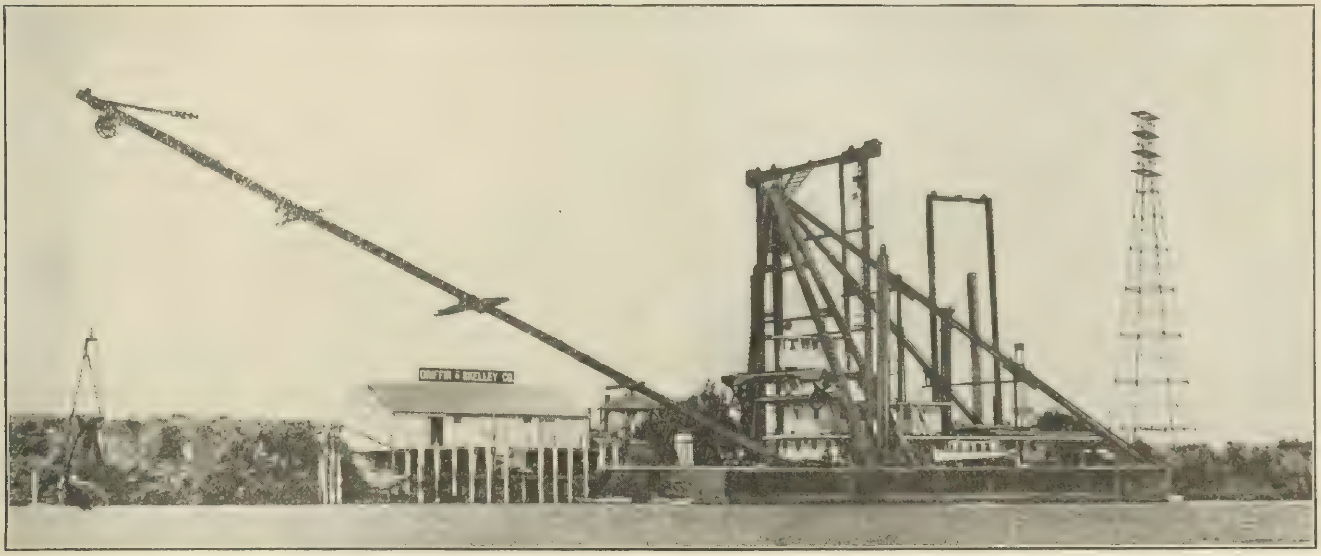


FIG. 1. CLAMSHELL DREDGE FOR BUILDING LEVEES ALONG CALIFORNIA RIVERS, WITH A 5-YD. BUCKET ON A 195-FT. BOOM

The hull has steel trusses and side plating, with bottom and deck of timber. It is 140 ft. long and 61 ft. 1 in. wide, with a depth of 13 ft. at the sides and 13½ ft. at the center. The side plating is ⅝ in. thick, made in two courses. The plates were made as long as possible, some being 50 ft. in length. Where the side plating is attached to the bottom of the hull, it is reinforced with an angle 8x8x⅝ in. bolted to a 12x18-in. timber. This angle extends the full length of the hull. The upper edge of the side plating is reinforced with an 18-in. angle plate, knuckled down 6 in. The vertical side frames are 12-in. 20-lb. channels, spaced 3 ft. c. to c. The transverse frames are of 12x12-in. timbers, connected to the vertical frames by ⅜-in. gusset plates.

The hull has two main longitudinal trusses extending its entire length and a center longitudinal truss about 60 ft. long. Connecting these are three transverse trusses, two immediately below the A-frame and one about two-thirds of the way aft, or just in front of the boiler. The longitudinal trusses are of 12-in. 20½-lb. channels and 10-in. Bethlehem H-beams. The cross-trusses have 12-in. channels for the bottom members and 10-in. channels for the top members, the diagonal members being 6-in. Bethlehem H-beams. Considerable trouble was experienced in so designing and placing the trusses that they would not interfere with the machinery, since the winding gear, engines, etc., are all below deck. The living accommodations, operating house, owner's quarters, etc., are above deck and are worked in between the members of the A-frame.

The A-frame consists of three legs on each side, all terminating in one point that supports a cast-steel cap. This in turn takes the topping-lift, which supports the outer end of the boom. The forward legs are 20x20-in. timbers 76 ft. long, in one piece for each side, and the cap is 68 ft. above the deck. The back legs are made out of 12x16-in. timbers in two pieces. All the legs rest in cast-iron sole plates on the deck. Immediately behind or aft of the A-frame is the gallows frame for lifting the spuds. This is made of 18x18-in. timbers, 78 ft. long, and extends down to the bottom of the hull. To take up the tension strains on the A-frame there is a system of 3-in. rods with turnbuckles. These connect to heavy chain-plates fastened to the side plating.

The boom is made up of three lengths, the outer section being 20x22 in. and the other two sections 22x22 in. The total length of the boom is 195 ft. It is trussed

vertically and laterally, long timber spreaders carrying the side truss rods. To take care of the list of the dredge, which takes place when the boom swings at 90° from the center line, the A frame cap is 5½ ft. forward of the pivot point of the lower end of the boom, known as the heel casting.

When the boom is swung at right angles, the dredge will have considerable list; and this offset permits the boom to swing around on practically a level plane. In fact, the builders state that a well-balanced dredge should be so arranged that when the bucket is dumped the dredge will right itself sufficiently so that the boom will swing back of its own accord. The swinging of the boom is taken care of automatically by means of two bucket lines, the closing line being the right-hand line and the dumping line the left-hand line. The point where these lines connect with the A-frame in this dredge is 18 ft. from each side of the center of the dredge, or in other words, the leverage on an arm 195 ft. long is only 18 ft.

For rapid working the dredge must be carefully balanced. The operator drops the bucket and proceeds to hoist on the closing line; this puts a strain on the right-hand line, and the bucket begins to come up. At the same time the boom commences to swing around. When the desired point is reached, the operator lets go on the hoisting-line friction and the weight of the bucket falls on the opening line, which immediately opens and puts the strain on the opposite side of the boom. The boom then swings back to position, and the bucket is dropped for another load.

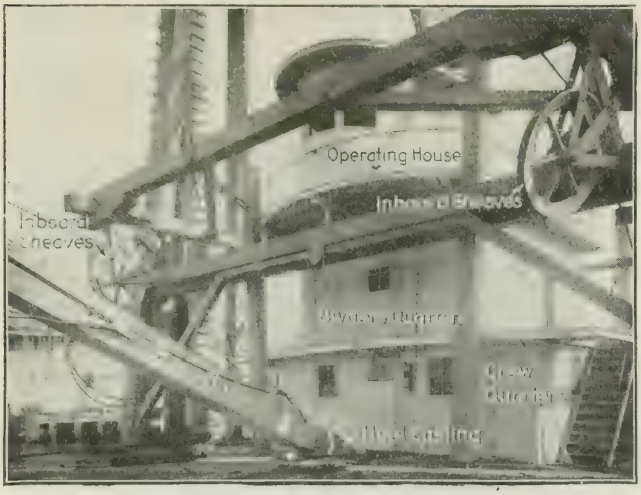


FIG. 2. OPERATING END OF CLAMSHELL DREDGE

The dredge has tandem cross-compound horizontal condensing engines, with cylinders 14x24 and 22x24 in., running at a maximum speed of 150 r.p.m. As the engines must be about 40 ft. apart, it is necessary to control the supply of steam by means of throttling valves placed immediately above the high-pressure cylinders. There is no flywheel, and the crank pins are set at 90°. There are two pinions on the crankshaft, which gear into the main drum gears, these gears being 10 in. in diameter, 10-in. face and 3-in. pitch. The gears have a flat surface about 8 in. wide on one side, on which are bolted V-shaped friction blocks. Various kinds of wood and fiber have been tried out, but sugar or bull pine is considered the best. As these friction blocks wear down, 2-in. pieces are put behind them and bolted up so that there is very little loss.

The friction races are V-shaped and bolted to the main reels or drums, which are 3 ft. 4 in. in diameter, with turned grooves for 1⅜-in. wire rope. Gears, friction races and drums are all of cast iron, the drums having bronze bushings. The friction races are forced on the friction blocks by means of a center pin and cross-cotter of the usual design, the pivot pin with a hardened-steel disk (all working in a bath of oil) being part of the outer bearing on the 7¾-in. drumshaft. This shaft is of forged steel.

The goose-neck lever that operates the center pin has a leverage of about 25 to 1, and the reach rod extends from the outer end of this lever to just outside the operating house. The operating lever proper consists of two pieces of 4x6-in. timber about 12 ft. long, placed horizontally, the ends being round and placed just high enough for the leverman to rest his elbows on them. The throttle lever is placed vertically between them and in front of the operator.

The dredge is held in position when at work by means of three spuds, two forward and one at the stern. The stern spud is known as a fleeting spud and is held in a steel frame, or carriage, which permits it to slide on the outside of the dredge. Thus when the point of the spud is held in the mud and the carriage is operated, the dredge will be pushed ahead. The forward spuds fit into cast-iron spud casings, or wells, which are situated on each side of the dredge as near the outside as possible and extend from the bottom of the hull to the deck. The forward spuds are 30x30 in., 70 ft. long. The fleeting spud is 24x24 in., 60 ft. long. The spuds are operated by the deck-hands, under signals from the leverman.

When the dredge is to be moved, or fleeted ahead, the bucket is dropped and both lines are tightened. The forward spuds are then raised, and with the fleeting spud on the bottom, steam is turned into the 15-in. cylinder of the fleeting carriage. This pushes the dredge ahead about 12 ft. The steam is controlled by a threeway cock. When the dredge is in its new position, the forward spuds are dropped. The fleeting spud is raised, and its carriage is moved ahead ready for the next fleet, or move. All spuds are raised by a double-cylinder 10x12-in. horizontal engine, which drives a 6-in. cross-drum shaft by means of a herringbone gear and pinion, with a gear ratio of about 8 to 1.

Water-Works Service Connections*

For water-works services smaller than 3 in. five different kinds of material are in use throughout the country—plain iron, galvanized iron, lead, lead lined and cement lined. Galvanized iron and lead are commonly used in this territory. In making a choise the determining factor would be that the material to be used should be that which represents the lowest cost during the life of the service, taking into consideration original cost, interest on the investment and cost of upkeep. The elements of cost are common labor for excavating; skilled labor to make up the service connections; brass parts for controlling the supply at the main and near the curb, and the service pipe with stop or valve boxes; cost of delivering the material; supervision and accounting.

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*Abstract of a paper read before the Minnesota Surveyors and Engineers Society by Garrett O. House, Superintendent of Water-Works, St. Paul, Minn., February, 1917.

In New England cities it is found as an average experience that galvanized iron will probably begin to give trouble after 15 yr. service and its life may be considered as 20 yr.; that lead pipe begins to give trouble in 10 yr. and that its life is 35 yr. In St. Paul experience shows that galvanized pipe begins to give trouble in 10 yr. or less and that its reasonable life under average conditions will not exceed 17½ yr., while lead service pipe, under ordinary conditions, has a life of 35 yr. and the time when trouble begins is very indefinite, as its trouble is due to settlement or accidental causes.

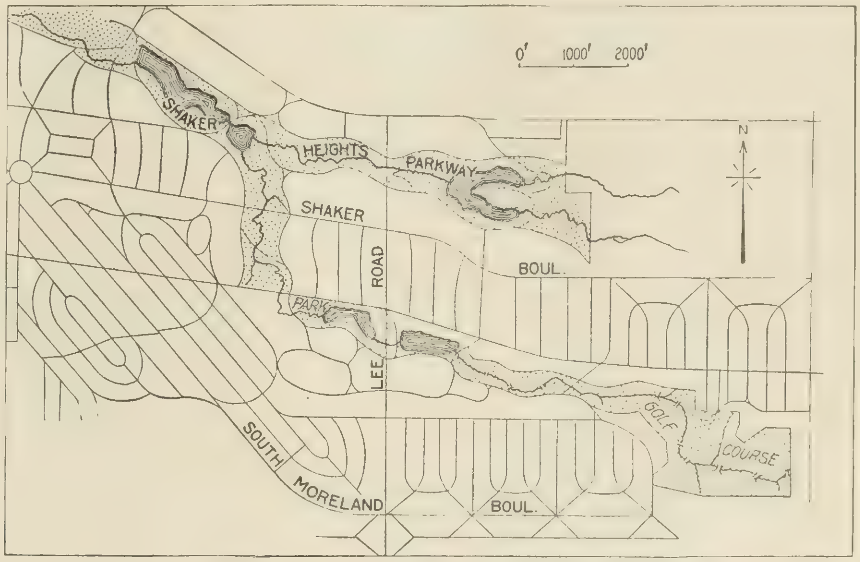
For the purpose of comparison a ¾-in. service pipe 50 ft. long is taken. This connection in lead pipe would cost $35 and in galvanized iron $25. Estimating the life of the lead pipe at 35 yr. and that of the galvanized-iron pipe at one-half that time, the depreciation on the lead pipe would be $1 per yr. and on galvanized-iron pipe $1.43 per yr. The interest on the lead service pipe would average 90c. per yr. through its life, and the interest on the investment on galvanized-iron pipe service would average 66c. throughout its life, or a total cost per year for lead-pipe service of $1.90 and for galvanized-iron pipe service of $2.09 per yr. It is the experience of those who have installed and maintained lead and galvanized-iron pipe services that, when galvanized-iron pipe becomes defective, the recurrence of leaks is frequent and expensive repairs are required until the time for replacement arrives. In the case of lead pipe, repairs on account of natural deterioration seldom have to be made for the first 20 yr., and we have found lead service pipe in perfect condition after 25 yr. The rules of the St. Paul Bureau of Water provide that the bureau furnish all materials and do all the work of installing service pipes from the water main to the property line, and the cost of this labor and material is paid by the property owner. The Water Department also makes all repairs to the water-service connections at the expense of the owner, the actual cost being charged therefor. As the owner of the premises is not permitted by the Department of Public Works to make any excavation in the street and is not permitted by the Bureau of Water to make any repairs to the water connections, and as the Bureau of Water makes the original installation, the owner has very little to say about it. Therefore, he should not be held responsible for other than natural deterioration of the service pipes, which should be guaranteed to him for a reasonable life; and the cost of maintenance and repairs should be at the expense of the Bureau of Water. The repairs usually necessary to water-service connections are due to imperfect workmanship or material, or to settlements, freezing or electrolysis, for none of which can the owner be held responsible.

Frozen water connections are one of the sources of anxiety both to the water department and to the citizen in this climate. The St. Paul Water Department uses a gas-engine electric generator set on a motor-truck trailer for thawing out water service (see *Engineering News*, Mar. 16, 1916). The records show that most services are relieved of ice within 2 min., and some of the more serious freezings have not required over 15 min. An arbitrary charge of $5 per service is made for the use of this thawing machine.

Some Original City Planning

The accompanying sketch shows some original ideas put into practice in laying out the streets of a suburban real-estate development near Cleveland, Ohio, known as Shaker Heights. The tract originally belonged to a colony of Shakers, which by 1889 had dwindled to two persons. They sold the property to a syndicate, which was responsible for the layout of some parts of the tract. The area labeled Shaker Heights Parkway was at that time given to the City of Cleveland for a public park.

Development of the tract proceeded slowly until 1906, when O. P. and M. J. Van Sweringen bought an interest in the syndicate. The new owners are responsible for a rearrangement of the street system, in which the governing features were topography and provision for rapid-transit service. The Van Sweringens are also the owners of the rapid-transit system (the Cleveland & Youngstown Ry.) that is being developed to serve this district, and it seems that the street layout, as will appear from an analysis, is designed for, and apparently well meets, the convenience of the railway operation. The object of the converging cross-streets on Shaker Boulevard and South Moreland Boulevard and the almost entire elimination of short blocks on these transit lines is to concentrate passengers at infrequent car stops. For example, the peculiar street layout on South Moreland Boulevard from Lee Road east makes necessary only one stop for five cross-streets, or one stop in 1,250 ft.



SKETCH PLAN OF SHAKER HEIGHTS VILLAGE, CLEVELAND, OHIO

The oval-shaped areas in the center of the tract are designedly inaccessible, for these are for the aristocratic element who have no need of street-car transportation.

B. L. Jenks, of Cleveland, attorney for the Van Sweringen interests, has been connected with the development of the project for several years. No architect or engineer is responsible for the general scheme or plan. The surveying and engineering work was done by the F. A. Pease Engineering Co., Cleveland.

Finding the Economical Suction Lift of a Centrifugal Pump

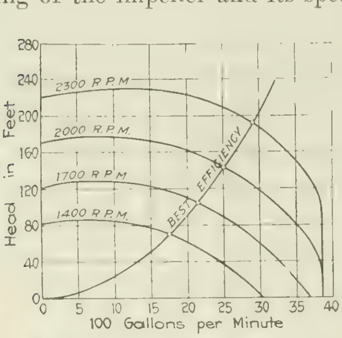
By Otto Haentjens*

What is the maximum suction lift that a centrifugal pump will efficiently carry? What is the suction lift for greatest efficiency? These are questions that have bothered designers for years. Failure to consider them has often given a pump a reputation of being poorly designed, where it has not worked as well as another one on the same lift. Most manufacturers state in their catalogs or rating tables that the suction should be kept as low as possible and should not exceed 15 ft., as for higher lifts a drop in capacity and efficiency is likely to occur. This is true in some cases, but the reverse has been observed in other instances up to a certain point. The author, in solving this problem, has developed certain "vacuum curves" that enable a designer to select the proper pump and impeller for any lift, and give the operating engineer a better understanding of conditions that govern the suction lift of a centrifugal pump.

In the following discussion mainly centrifugal pumps of the volute type are considered. All tests referred to were made on the factory test stand with double-suction volute pumps, and the piping and gages were arranged as shown in Fig. 1. To the vacuum-gage readings is added the distance *A*; and wherever the word "vacuum" is used, it signifies the distance of the water level to the center line of the pump plus the friction head in feet of water in the suction pipe up to the vacuum gage. The friction in the pump-suction elbow, in the impeller and in the volute chamber up to the point where the discharge gage is connected, interests only the designer and not the operating engineer.

Suction-Lift Relations

Assuming that the suction line is properly laid, that it is tight and contains no air pockets, and assuming that the water is cold and free from vapors, the vacuum which a centrifugal pump can produce depends then on the shape of the pump-suction elbow, or suction head, the inlet opening of the impeller and its speed, the ratio of outside diameter to inside diameter of the impeller, and the amount of water pumped. In order fully to understand the problem it is best to investigate the characteristic curves of one impeller at different speeds. As is well known, the capacity changes in direct proportion to the speed, and the head as the square of the speed. This holds good as long as the water velocities in the impeller and casing remain within certain limits. If they exceed these limits, the capacity falls off quicker than the above-mentioned law would indicate, until finally a point is reached where a further increase in speed does not increase the capacity. This point is called the "break point"; it is seen in the curves of Fig. 2, which represent the performance of an 8-in. double-suction volute pump. The break occurs at 3,850 gal. per min.



*Barrett & Haentjens, Hazleton, Penn. Formerly Chief Engineer, Jeanesville Iron Works Co.

The pump was set up as shown in Fig. 1, with about 15 ft. of 12-in. suction pipe between the elbow and the pump. The vacuum could be increased by throttling the gate valves in the suction pipe, and the long pipe served to straighten out the water before it flowed into the pump casing. The pump was first tested with the valve in the suction line wide open and the valve in the discharge line throttled for the various pressures. As the capacity increased, the vacuum naturally increased; the vacuum readings for the corresponding capacities were noted and are represented for 2,300 r.p.m. in Fig. 3 by a line called the "pipe-friction" curve. This shows the friction loss in the suction pipe for capacities ranging from zero to maximum.

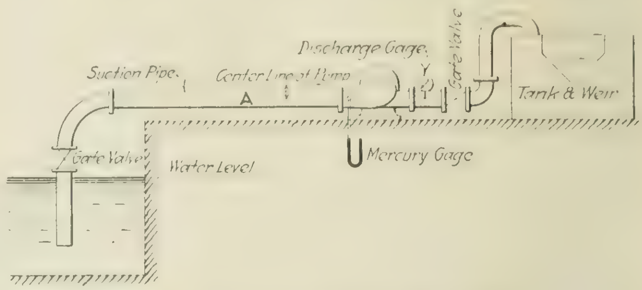
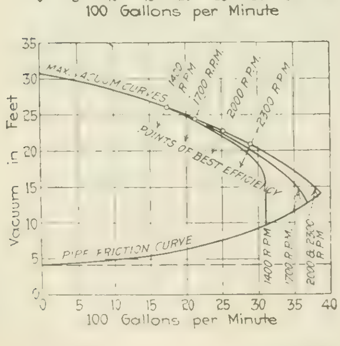
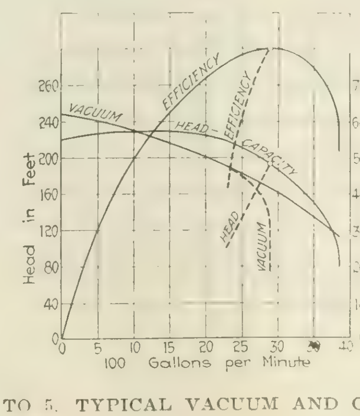
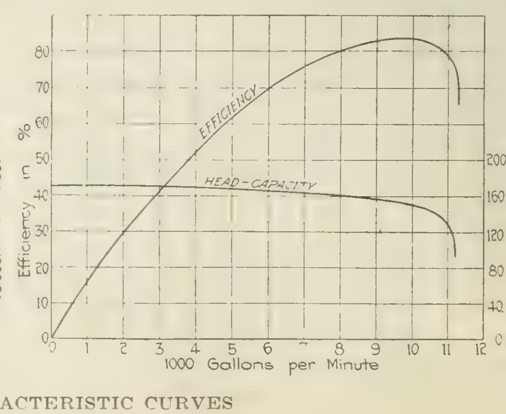


FIG. 1. PUMP-TEST ARRANGEMENT

The pump was then run with the discharge valve wide open, and the valve in the suction line was throttled. This increased the vacuum and decreased the capacity so that, as the discharge valve was always wide open, the maximum capacity for the various vacua could be determined. These readings are plotted in Fig. 3, giving a line here called the "maximum-vacuum" curve. The maximum-vacuum curve and the friction curve meet at the break point. The highest vacuum at the point of best efficiency for 2,300 r.p.m. was, according to the curve, 21 ft.; 13 ft. was therefore expended in forcing the water through the suction







FIGS. 2 TO 5. TYPICAL VACUUM AND CHARACTERISTIC CURVES

head into the impeller. This head is lost, all except the velocity head corresponding to the velocity increase of the water flowing from the suction elbow into the impeller eye.

Fig. 4 shows the maximum-vacuum curves for 2300, 2000, 1700 and 1400 r.p.m. It will be noticed that for the points of best efficiency the maximum vacuum increases as the speed decreases. An impeller in a volute pump, therefore, when working at the best efficiency point, can produce a higher vacuum at low speed than at high speed. If conditions require high speed and at the same time high vacuum, the pump must be so designed that the condition point on the curve is ahead of the best efficiency point; in other words, efficiency must be sacrificed in order to obtain high vacuum. It will further be noticed that, especially at high speed, the pump rapidly loses its faculty to produce a high vacuum after the best efficiency point is passed and the condition point comes nearer to the break point. Volute pumps having a characteristic curve of the shape shown in Fig. 6 are therefore not suitable for high vacuum.

High Vacuum and Efficiency

So far we have considered only the highest obtainable vacuum and disregarded the efficiency of the pump. In order to obtain the best efficiency it is essential that pump and impeller passages are perfectly filled with water when the pump is running. If the impeller throws out more water than the inlet can pass, the stream in the impeller passages breaks off. The unfilled condition exists for all points along the maximum-vacuum curve.

Referring to Fig. 2, the pump at 2,300 r.p.m. worked most efficiently when pumping 2,900 gal. per min. against 195 ft. total discharge head. From Fig. 3 we know that the vacuum was 9 ft. when pumping this quantity of water with the valve in the suction line wide open. This test was repeated and the discharge valve throttled to produce 195 ft. total delivery head. The efficiency was found to be 80%. The vacuum was then increased by throttling the valve in the suction line, leaving the valve in the discharge undisturbed, and capacity, head and power readings were taken. The efficiency remained constant until the vacuum was increased to more than 16 ft. Then head, capacity and efficiency began to fall until finally, when the maximum vacuum was obtained, head and efficiency had dropped about 50%. The heavy curves in Fig. 5 indicate the change in head and efficiency at the various degrees of vacuum.

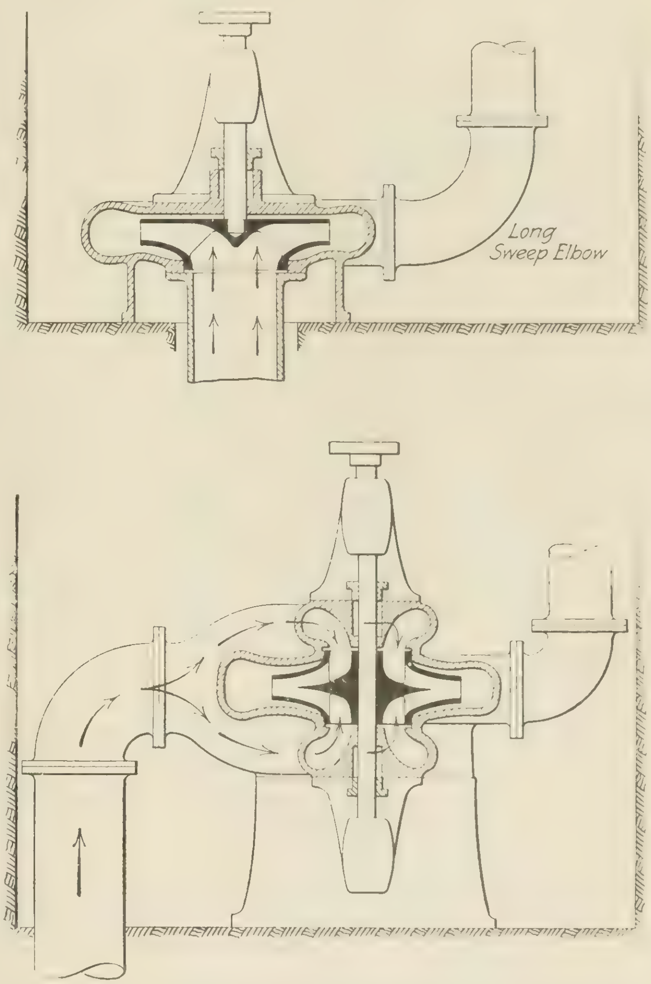
A great number of tests showed that in order to maintain the best efficiency the vacuum must be about 5 ft. lower than indicated by the maximum-vacuum curve. It was also found that when increasing the suction lift from minimum to maximum, the efficiency would in most cases first increase slightly and then decrease. This increase amounted to 1 or 2% and in some cases to 3%. While it is a very difficult matter to make pump tests within such close limits and errors may have occurred, the fact that almost all tests showed the same phenomenon creates the belief that a centrifugal pump works more efficiently on a moderate than on a very low suction lift.

Improved Pump Practice

The foregoing refers to volute pumps without a diffusion ring. The introduction of a diffusion ring makes it possible to use at high speed low velocity in the suction elbows and the impeller eye and still obtain good efficiency.

The many failures of centrifugal pumps working on high suction lifts could have been avoided if the manufacturers had established vacuum curves for their pump casings. The tests should be made with impellers of varying diameter, as impellers having short vanes do not produce as high a vacuum as impellers having a larger ratio of outside to inside diameter. A volute pump working efficiently on 15-ft. vacuum may fall off considerably if the vacuum is increased to 18 ft., and especially pumps having a characteristic like Fig. 5 are uncertain in operation on high vacuum.

For the designer the vacuum curves give a good check on the design of the casing. Suppose the same impeller



FIGS. 6 AND 7. COMPARISON OF SINGLE- AND DOUBLE-SUCTION WELL PUMPS

is installed in two pump casings having the same suction and discharge openings and the vacuum curves are established. The casing that produces the higher vacuum and passes at the same time the greater amount of water will be more efficient. It is of course assumed that the impeller is correctly designed.

The correct design of the suction head, especially of double-suction pumps, is of the utmost importance. Much valuable information regarding the flow of water in elbows and through the impeller is contained in a paper by F. zur Nedden, in the August, 1915, issue of the "Proceedings" of the American Society of Civil Engineers, and particularly in the discussion by C. G. de Laval in the November, 1915, "Proceedings," where he shows that by changing

the suction entrance of double-suction volute pumps the capacity was increased 10 to 50%.

The water in a double-suction pump flowing from the suction head into the impeller has to make a turn of 90°. In a vertical single-suction pump the water flows along a straight path directly into the impeller. Such a pump, therefore, must give the highest efficiency, and it is peculiar that this type has not been more perfected. Instead manufacturers now abandon single-suction vertical pumps and recommend for wells their double-suction pumps set in a vertical position. The space in a well is as a rule very limited; and in addition to the turn the water has to make in the casing, short elbows must be used on the suction and discharge (see Figs. 6 and 7). This is detrimental to high efficiency. The speed of vertical pumps as a rule is not so high, but that single-suction impellers could be used to good advantage; the tendency to substitute double-suction for single-suction is a step in the wrong direction

Excess Rock Excavation in Catskill Aqueduct Tunnels

By M. E. Zipser*

SYNOPSIS—The author reports the experience in driving nearly 50 mi. of tunnels for the Catskill Aqueduct with respect to the amount of rock excavated outside the surface of the neat tunnel lining. The figures are of value to every engineer who may have to estimate on tunnel construction or to draw specifications for rock-tunnel work.

To engineers and contractors engaged in tunneling work, it is of advantage to have information in regard to the excess excavation that may be expected in driving a rock tunnel, in order that a fairly close estimate may be made of the actual number of cubic yards of rock that must be handled. If the tunnel is to be lined, the data for excess excavation are also of importance in estimating the quantity of masonry required for lining. On contract work, the information is of especial value to enable the engineer to fix, in advance, equitable lines limiting the cross-section in which excavation and masonry lining will be paid for.

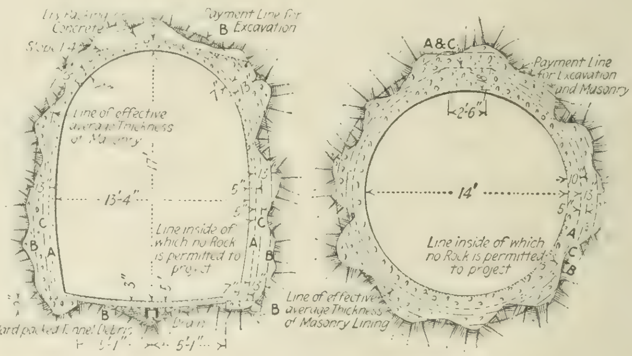
The question of payment for excavation and for concrete outside of the neat lines of a tunnel has been a source of much controversy in tunnel construction and has frequently resulted in prolonged litigation. Where payment is made on the basis of the actual quantities, careless work and increased cost are likely to follow. For it is obvious that where definite lines are not fixed in advance, limiting the amount of excavation and masonry that will be paid for, it is a difficult matter to control the size of the excavation, as the contractor profits by wide breakage.

On the other hand, where no payment is allowed for excavation outside the line defining the minimum required thickness of lining, the contractor does not receive payment for the amount of rock necessary to excavate, since the rock will necessarily break outside of this line. This method of payment, therefore, is unfair to the contractor, particularly where the breakage is very wide through no fault of his. When the Croton Aqueduct was built, no allowance was made for rock excavated outside the specified masonry lines. The contractors sued the city, and after protracted legal proceedings they secured partial payment through an Act of the Legislature.

In this article an attempt has been made to give all the available data on the actual breakage in the excavation of the various rock tunnels of the Catskill Aqueduct. The entire aqueduct, which will convey water from the Catskill Mountains to New York City, comprises a total of 127 mi., of which 49 mi. is in tunnel.

Two standard types of tunnel were employed. These (shown in Figs. 1 and 2) are designated as the grade and the pressure tunnel respectively. The grade tunnels pierce ridges and mountains on the hydraulic gradient, and the pressure tunnels cross the broad and deep valleys. The latter type of tunnel also forms the great distribution main within the city limits. There are 24 grade tunnels in all, aggregating 14 mi. in length, and 9 pressure tunnels totaling 35 mi. The tunnels are lined throughout with portland-cement concrete.

The size of the tunnels and the minimum required thickness of lining vary, the dimensions indicated on the cross-sections being typical of the tunnels in unsupported



FIGS. 1 AND 2. CROSS-SECTIONS OF TUNNELS, CATSKILL AQUEDUCT

ground. The pressure tunnels have a finished inside diameter varying from 16 ft. 7 in. to a minimum of 11 ft.

In preparing the plans and specifications for the Catskill Aqueduct under the direction of the Chief Engineer, J. Waldo Smith, an extensive study was made of the breakage of rock in many well-known tunnels. Based on the results of these studies, the lines shown on the cross-sections, Figs. 1 and 2, were adopted.

The *A* line indicated on these sections is the line within which no rock is permitted to project. This line, therefore, defines the minimum thickness of masonry lining and corresponds to the line ordinarily designated in tunnel work as the clearance, or the neat, line. Whatever volume is actually excavated, the specifications provide that payment for excavation will be made to the *B* line, which in unsupported portions of the tunnel is parallel to

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DATA ON TUNNEL BREAKAGE, CATSKILL AQUEDUCT

Rock Formation	Name of Tunnel	Contract No.	Type of Tunnel	Distance Between the A Line and the Average Line of Actual Excavation, In.	Length of Tunnel on Which Data Are Based, Ft.	Remarks
Shales and Slates:						
Hamilton shale..	Peak	11	Grade	12	3,350	Firm shale uniform in character, bedding nearly horizontal
Marcellus shale.....	Rondout	12	Pressure	12½	1,770	Rock rather soft, sealed on exposure to air, requiring temporary timber support; dip generally slight, strike approximately 45 deg. to center line of tunnel
Esopus shale..	Rondout	12	Pressure	11¾	5,590	Hard shale, favorable to tunneling; dip generally less than 10 deg.; tendency to break high in north half of stretch, which was timbered
Hudson River shale...	Bonticou	12	Grade	11	3,300	Thin bedded, uniform in structure; dip 70 deg. to 90 deg., strike nearly at right angles to tunnel axis
Hudson River shale.	Bonticou	47	Grade	15¼	2,830	Strike generally 25 deg. to 45 deg. to tunnel axis, 40 deg. to 80 deg.; bench broke wide
Hudson River shale.	Rondout	12	Pressure	12¾	5,900	Rock of same general character as in Bonticou grade tunnel. Contract 12
Hudson River shale.	Wallkill	47	Pressure	11¾	22,020	Dip horizontal to vertical, strike about 45 deg. to tunnel axis; rock in northerly half of tunnel rather soft and thin bedded; very hard sandstone in stretches in southerly half
Hudson River shale....	Moodna	20	Pressure	13¼	17,620	Sandstone and shale in heavy beds; strike generally 50 deg. to 85 deg. to tunnel axis; rock blocky in portions with numerous joints and faults
Average, shales and slates...			...	12½	62,380	
Limestones:						
Helderberg series.	Rondout	12	Pressure	11½	2,690	Nearly horizontal bedding; Port Ewen hard and cherty. Becraft broke high in roof, New Scotland blocky, broke rectangular
Inwood............	Pleasantville	55	Grade	19¾	660	Crystalline limestone, partly blocky and broken up by sand seams
Inwood............	City	65	Pressure	15	870	Strike nearly at right angles to tunnel axle, dip about 75 deg.
Inwood...........	City	67	Pressure	17	2,600	Crystalline rock, blocky; strike generally parallel to tunnel axis, dip about 55 deg.; holes in bench drilled too deep
Average, limestones			......	14¾	6,820	
Shawangunk Grit:						
	Roundout	12	Pressure	16	1,890	Very hard quartz conglomerate; bedding nearly horizontal; numerous joint planes tended to break square at bottom
Granites, Gneisses and Schists North of New York City:						
Gneissoid granite.	Moodna	20	Pressure	16	6,360	
Gneissoid granite.	Moodna	160	Pressure	15	800	Hard granite, fairly uniform, numerous joint planes
Gneissoid granite..	Breakneck	80	Pressure	13¾	740	
Gneissoid granite.	Hudson	90	Pressure	13¾	1,500	
Gneissoid granite.	Breakneck	80	Grade	14¼	1,050	Same as granite above; tunnel excavated by bottom heading
Gneissoid granite.	Cat Hill	2	Grade	18½	2,350	Heavy joint planes; tunnel very carelessly driven
Granitic gneiss	Bull Hill	22	Grade	15¾	5,140	Blocky, jointed rock; tunnel poorly driven
Granitic gneiss	McKeel	2	Grade	11¼	900	Uniform rock; tunnel driven with care
Granitic gneiss	Garrison	2	Grade	15¼	10,400	Material varied from soft, disintegrated rock to very hard, blocky quartzite; numerous joint planes; portion of tunnel poorly driven
Fordham gneiss.....	Millwood	55	Grade	16¼	4,350	Sound hard rock; contractor aimed to excavate sufficiently large to avoid trimming
Fordham gneiss.....	Sarles	55	Grade	17	5,230	
Manhattan schist....	Croton Lake	24	Pressure	15	2,600	Uniform material, some jointing
Manhattan schist...	Reynolds Hill	55	Grade	21	2,800	Poor ground, rock much disintegrated and broken
Manhattan schist.	Hunter's Brook	23	Grade	20	4,880	Rock varied from soft disintegrated schist to dense, hard, close-grained material badly jointed in places; frequent crushed zones, bottom heading excavation
Manhattan schist......	Turkey Mountain	24	Grade	15½	1,270	
Manhattan schist......	Croton	25	Grade	15¾	2,990	Rock fairly uniform and sound; some jointing
Manhattan schist......	Chadeayne	25	Grade	15¾	550	
Average, granites and gneisses......				15¼	38,820	
Average, Manhattan schist......				18	15,090	
Gneisses and Schists in and Near New York City:						
Yonkers gneiss........	Yonkers	54	Pressure	17¼	10,880	Sound hard gneiss, excessive breakage due to careless and reckless driving; bonus system used part of the time
Yonkers gneiss	Yonkers	30	Pressure	12½	1,160	Sound hard rock; very carefully driven, and closeness to lines also due to use of horizontal drill holes, tunnel being driven by bottom heading
Yonkers gneiss	Van Cortlandt	30	Pressure	12½	1,790	
Yonkers gneiss	City	63	Pressure	18¾	7,330	Strike nearly parallel to center line of tunnel, joints very numerous, ground hard and blocky, cut in many places by disintegrated zones; contractor aimed to excavate sufficiently large to avoid trimming
Fordham gneiss....	City	63	Pressure	16¾	11,040	
Fordham gneiss..	City	65	Pressure	15	5,860	Rock hard and uniform for greater length of tunnel; some poor ground in northerly portion
Fordham gneiss..	City	67	Pressure	17	2,300	Rock hard and blocky with numerous joints, considerably folded and disturbed; holes drilled too deep in bench
Granodiorite (gneiss)...	City	67	Pressure	15¾	2,300	Hard crystalline dense rock
Manhattan schist......	City	65	Pressure	15½	17,640	Medium hard, generally sound rock, of good quality for tunnel driving; strike nearly parallel to tunnel axis, bedding usually steeper than 45 deg.
Manhattan schist.	City	66	Pressure	15¼	22,270	
Manhattan schist.	City	65	Pressure	13¾	770	Strike approximately at right angles to center line of tunnel
Manhattan schist.	City	67	Pressure	17	4,780	Rock of same general character as on Contract 66; bench was drilled too deep, resulting in excessive breakage in bottom
Average, gneisses........				16¼	42,660	
Average, Manhattan schist				15½	45,460	

and 13 in. outside of the *A* line, as shown on the sections, Figs. 1 and 2. This 13 in. was determined from the tunnels investigated, as an average figure for the distance that the rock broke back of the clearance line in tunnels driven with reasonable care. The *B* line is also the payment line for concrete masonry where the concrete is placed against the rock.

The *C* line shown on the cross-sections is defined in the specifications as "the line of effective average thickness of masonry lining." The *C* line is placed generally

5 in. outside of the A line, and the specifications provide that the lining shall everywhere actually average to the C line, the rock being trimmed back of the A line where necessary.

In addition to payment for excavation and concrete to the B line, the tunnel contracts for the Catskill Aqueduct contain an item called "Excess Concrete Masonry in Shafts and Tunnels," which provides that the number of cubic yards, if any, by which the actual quantity of concrete exceeds the theoretical quantity (measured to the B line) for each stretch of 100 ft. shall be paid for at a fixed price, which is either \$2.50 or \$3 per cu.yd. This item for excess concrete provides some compensation where the breakage is very wide; but as there is no profit in the price stipulated for this item, there is no incentive for the contractor to excavate recklessly. It should be noted here that on all the aqueduct contracts, cement is paid for separately on the basis of the number of barrels actually used in the work.

The relation between the A, or clearance, line and the average line of actual excavation in the various tunnels is shown in the accompanying tabulation. The figures are based on cross-sections generally 10 ft. apart, taken in the tunnel either by the Sunflower instrument or by measurements from the forms used for lining the tunnels. The data in the table do not include those portions of the tunnels that were permanently supported either by timbering or steel roof support. In some of these stretches the excess breakage was very large. Particularly so was this the case in the roof where, owing to the character of the ground and other local conditions, various types of support were used. In permanently supported tunnels, the specifications fix the B line, or payment line for excavation, 13 in. outside of the support.

The data on tunnel breakage have been classified in the table according to the rock formation. The figures in the table show that, of all the rocks included in this outline, the shales and slates generally broke closest to lines, the average position of the actual excavation line being 12½ in. back of the A, or clearance, line, based on a length of nearly 12 mi. of tunnel. Exceptionally good results, however, were obtained in the Helderberg series of limestones, where the distance between the A line and the excavation line, as shown in the table, averaged only 11½ in. In the other formations the table shows that the excess breakage, with one or two exceptions, was considerably larger. In the Inwood limestone the distance to the excavation line averaged 17 in., in the Shawangunk conglomerate 16 in., and in the gneisses and granites the distance varied from 11¼ to 18¾ in., the average being about 16¼ in. In the Manhattan schist there is also a wide variation from a minimum of 15 in. to a maximum of 21 in., the very wide breakage occurring in the poor ground encountered in two of the tunnels in the Croton Valley.

While the kind of rock is one of the important factors that affect the breakage, the condition of the rock, the prevalence and direction of joint planes, the dip and strike, etc., are also important. In the same formation the breakage will be influenced according to whether the tunneling is at right angles or nearly so to the beds, or whether it runs along the strike; whether the ground is fairly solid and undisturbed or whether it is broken and crushed. The wide breakage in the City tunnel was in large part due to the fact that the strike generally was nearly parallel to the center line of the tunnel. In the northern portion of the City tunnel, numerous joint planes and the poor quality of the rock also contributed to the excess excavation. In short stretches of the City tunnel, where the tunnel cut across the strike, much closer breakage was obtained.

The closeness to lines depends also on the method followed in driving the tunnel. Some superintendents will excavate a tight section that is subsequently trimmed out, the trimming being done either simultaneously with the excavation or after the headings are holed through.

Others again prefer to excavate sufficiently wide in the first place to avoid the expense and loss of time by subsequent trimming. The latter scheme is probably more economical to the contractor, particularly in hard and tough rocks like granite, which cannot be drilled by the ordinary Jap drills used for trimming in the softer rocks. The percentage of excess excavation, however, must not be so large as to involve the handling of too great a yardage of extra excavation and concrete.

The most important factor in securing a well-driven tunnel, other conditions being equal, is the care used in the placing, pointing and loading of the drill holes. It was the practice of the engineers, generally, during the driving of the tunnels to call the contractor's attention to the results being obtained, by means of cross-sections taken frequently during the progress of the work to show the actual breakage lines. Where the contractor coöperated with the engineer in this matter, excellent results were obtained, the contractor effecting a considerable saving in the amount of excavation and concrete by the close breakage to lines. For example, in the Wallkill pressure tunnel, Contract 47, the actual excavation was approximately 6000 cu.yd. less than the quantity paid for, and the contractor was also paid for 6000 yd. of concrete masonry that was not placed.

The influence of care and organization in the results secured is strikingly illustrated in the case of the Yonkers pressure tunnel, where on two adjacent contracts in the same tunnel the distance between the A line and the average line of excavation, as shown in the table, was 17¼ in. on one contract and 12½ in. on the other. The rock was practically identical on both contracts, and the excessive over-breakage in the one case was due to very careless driving, while the excellent results obtained in the same tunnel on the other contract were mainly due to the care exercised by the contractor's superintendent. The use of a large number of horizontal rim holes in the excavation of the lower half of the circular tunnel driven by the bottom-heading method on the latter contract also contributed to the close breakage.

It is on account of the many factors that influence the breakage, as enumerated above, that the position of the actual excavation line as indicated in the table is found to vary widely, even in the same rock formation, and the data assembled should be regarded as furnishing averages under various conditions.

Another point to consider also is that the excavation in the tunnels on which the data are based was governed by the C line in addition to the A, or clearance, line. Where only a clearance, or neat, line is specified, as is generally the practice on tunnel work, the average line of actual excavation, particularly in rocks breaking close to lines, may be expected to be closer to the clearance line than the figures in the table indicate.

Old Macadam of Little Value as Base for Concrete Pavement

By D. A. Thomas*

That an old macadam road offers but little immediate advantage as a foundation for a permanent surface is the opinion of the Michigan State Highway Department.

Take a specific example: On account of a great increase in automobile traffic an old macadam road a mile in length connecting Lansing and East Lansing, Mich., built in 1906, given a bituminous-surface treatment three years later and two years ago resurfaced with gravel, which was in turn treated in an effort to enable the surface to withstand the traffic, has recently been reconstructed with concrete pavement under the direction of Leroy C. Smith, deputy state highway commissioner.

The improved stretch lies on the route of the Wolverine Pavedway, which is a much traveled through route as well as a most important market road. Over this road most of the traffic to and from the Michigan Agricultural College, located in East Lansing, passes. In addition, the highway is much used for pleasure driving. With the advent of the extended use of the automobile this combination of conditions has caused the traffic to more than triple since the original improvement of the road. The average number of vehicles passing over the road daily is now over 1000, of which approximately 85% is motor driven.

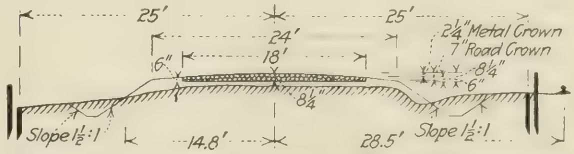
In 1906 the volume of the traffic, though largely horse drawn, necessitated some form of improved road. Macadam was selected in the belief that it would serve the needs of the community for years to come. As originally built, the road was two miles long and extended from Lansing through and beyond the limits of East Lansing, whereas only that portion lying between the two cities has been rebuilt with concrete. The road was constructed in two courses with a limestone base and a top of crushed fieldstone forming a compacted depth of 6 in. The width of macadam was 15 ft. The width between side ditches was 22 ft. The total cost was $13,485, or approximately $6750 a mile. The road was built according to the first specifications of the State Highway Department and was among the earliest applied for, its application number being 27.

For a year or two the commissioners were allowed to enjoy a period of complacent pride in their work. But in 1909 the road had become quite badly rutted, and it was accordingly scarified, reshaped and treated with asphaltic oil by the penetration process. Each year, however, witnessed a large increase in the traffic and a gradual change from horse-drawn to motor-driven vehicles, which left the road in bad condition at the end of the season. In 1914 it was apparent that the road must be resurfaced in some manner. An abundance of good gravel was available, and it was decided to resurface the road with this, since the lack of funds prevented extensive reconstruction. The gravel was placed to a greater depth at the center, to form a small crown, since the old surface had become worn quite flat. When the gravel was thoroughly compacted and shaped, the surface was treated with glutrin.

In the short space of two years, in spite of some attempt at maintenance, the gravel was displaced, and the road became so badly rutted and full of holes that a car could not proceed over it at a speed greater than 10 mi. per hr. without discomfort to the passengers.

This summer, when it was evident that immediate steps must be taken to reconstruct the road with some form of permanent surface, the State Highway Department offered to undertake the reconstruction by force account with funds furnished by local parties and by the county, together with the state reward which the road would merit. Concrete was selected as the most feasible type to build.

It is manifestly poor policy to construct an expensive surface or a relatively long-lived surface on defective grades with poor alignment or where the drainage features are short lived and temporary. As is the case with a majority of the early macadam roads, the grade of this road showed an undulating profile that followed closely the lay of the land. In rebuilding for the future it was deemed best to introduce longer and easier grades. No change in alignment was necessary, but the width of the roadway was increased from 22 ft. to 24 ft., the side



TYPICAL CROSS-SECTION OF CONCRETE PAVEMENT LAID OVER OLD MACADAM

ditches deepened and widened and new culverts with suitable headwalls provided at intervals. The excavation from the ditches was used to widen the roadway.

There is an additional reason, however, why in the majority of instances an old gravel or macadam surface cannot serve at once as a foundation for a concrete surface or pavement having a concrete base. The surface is usually rutted, full of hollows and not uniformly hard. If filled with loose material that is improperly compacted, the concrete slab will be supported on the highest portions of the old bed. This condition will tend to produce cracks and will shorten the life of the pavement. In accordance with this principle the old surface, which, as has been stated, was badly rutted, was scarified, cuts and fills made, and rerolled until uniformly compacted. The old metal taken from the shallow cuts was used where the small fills were necessary.

The concrete was deposited over an 18-ft. width in one course $8\frac{1}{4}$ in. thick at the center with a $2\frac{1}{4}$-in. crown. A 1:2:3½ mix with washed gravel as coarse aggregate was used. Expansion joints were placed only at points where the work was stopped for more than 30 min. The length surfaced was 1.083 mi. The total cost was $17,500, or $1.51 per sq.yd.

The writer, as an employee of the Michigan State Highway Department, has been in close touch with the rebuilding of the road and has had access to the facts and information concerning the original construction. It is believed that the conditions surrounding this road are applicable to many old macadam roads in the country. The procedure described in this article is typical of the practice followed in Michigan in rebuilding an old macadam road with a surface of a permanent type.[1]

*Michigan State Highway Department.

[1]In drawing any conclusions from the experience outlined in the foregoing article the reader should bear in mind that a 6-in. limestone macadam road is quite different from the 10- and 12-in. granite and traprock macadam constructed in the early days of the good-roads movement in some of the Eastern States.—Editor.

FIG. 1. VIEW OF LAKE MATTAMUSKEET PARTLY DRAINED
Looking north from roof of partly completed power station. Showing central and east and west main canals, and town site of New Holland

Big Drainage Project in North Carolina with Rural-District Plan

SYNOPSIS—By unwatering Lake Mattamuskeet in Hyde County, North Carolina, near Pamlico Sound, the largest pump-served drainage district in this country—and probably the largest in the world except for the polders of Holland—has recently been opened up. The largest land owners of the district (controlling the entire bed of the lake, which is half the benefited territory) have what is probably the most ambitious rural-district plan that has yet been developed for the physical and social improvement of the locality as an agricultural district.

Lake Mattamuskeet was one of the largest shallow lakes in the East and the largest lake in North Carolina, being some 14 mi. long by 6 mi. wide. It was merely a shallow basin into which the slightly higher land around had drained; although only 8 mi. from the ocean, it had no natural outlet.

The land around the lake has always been notable for its fertility and has been under cultivation for 200 years. The first project to drain Lake Mattamuskeet dates back to 1773. In 1789 a drainage board was appointed for the district—perhaps the first drainage board in the United States. Under its direction a small canal was dug, but it served only to lower the surface of the lake slightly and to keep it more constant. The lake today is about half the extent reported in 1750.

The Drainage Project

Many years ago title to the lake bed passed to the State Board of Education of North Carolina, and it was held by it until sold to the present owners. The present project for completely draining the lake arose about 1909, at which time the help of the United States Department of Agriculture was secured and a soil survey was made. North Carolina passed a general drainage law in 1909, and a special act pertaining to this project. The district included 48,830 acres of lake bed and 50,000 acres surrounding. It proved a difficult matter to define the lake bed, but the state organized a survey and the limits were finally agreed upon with the adjacent property owners.

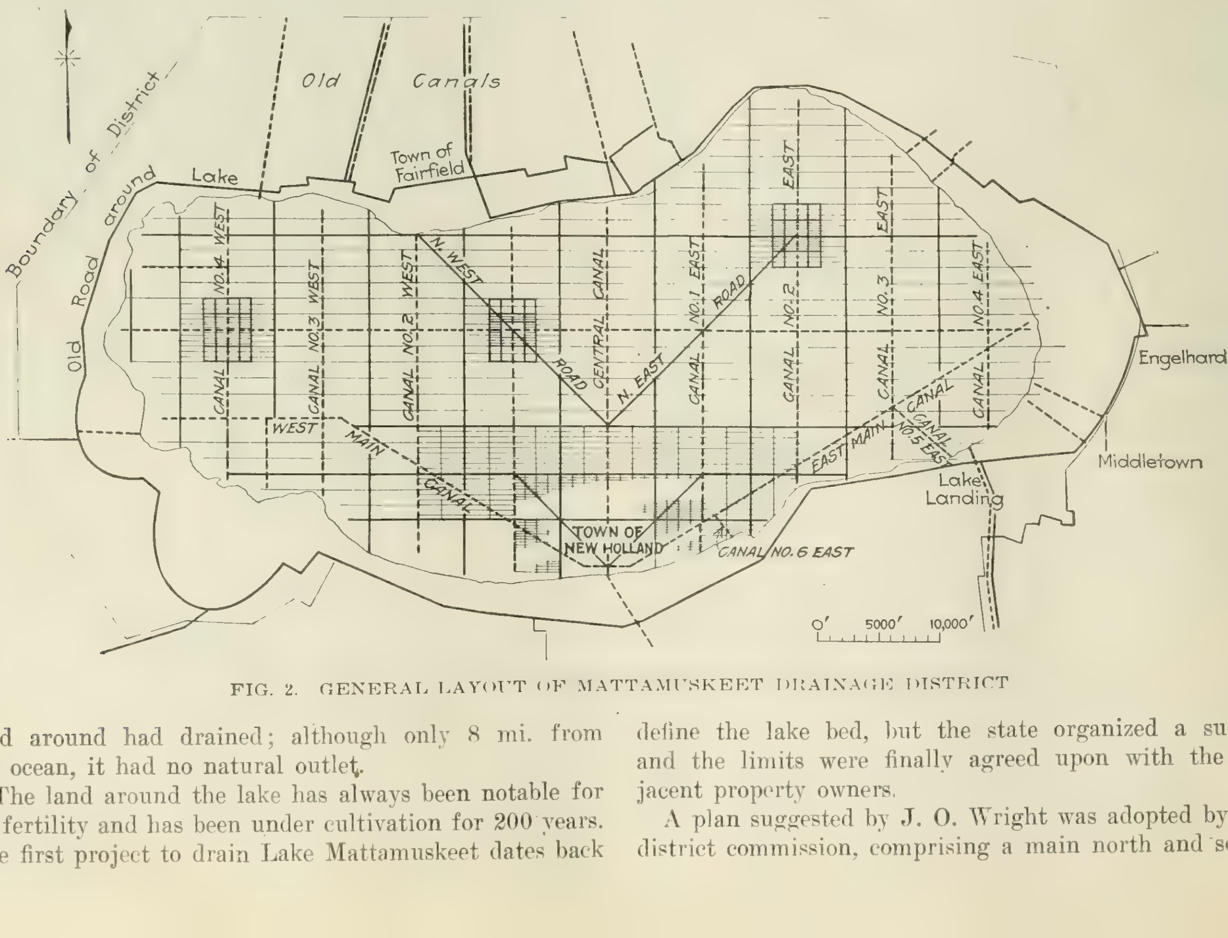


FIG. 2. GENERAL LAYOUT OF MATTAMUSKEET DRAINAGE DISTRICT

A plan suggested by J. O. Wright was adopted by the district commission, comprising a main north and south

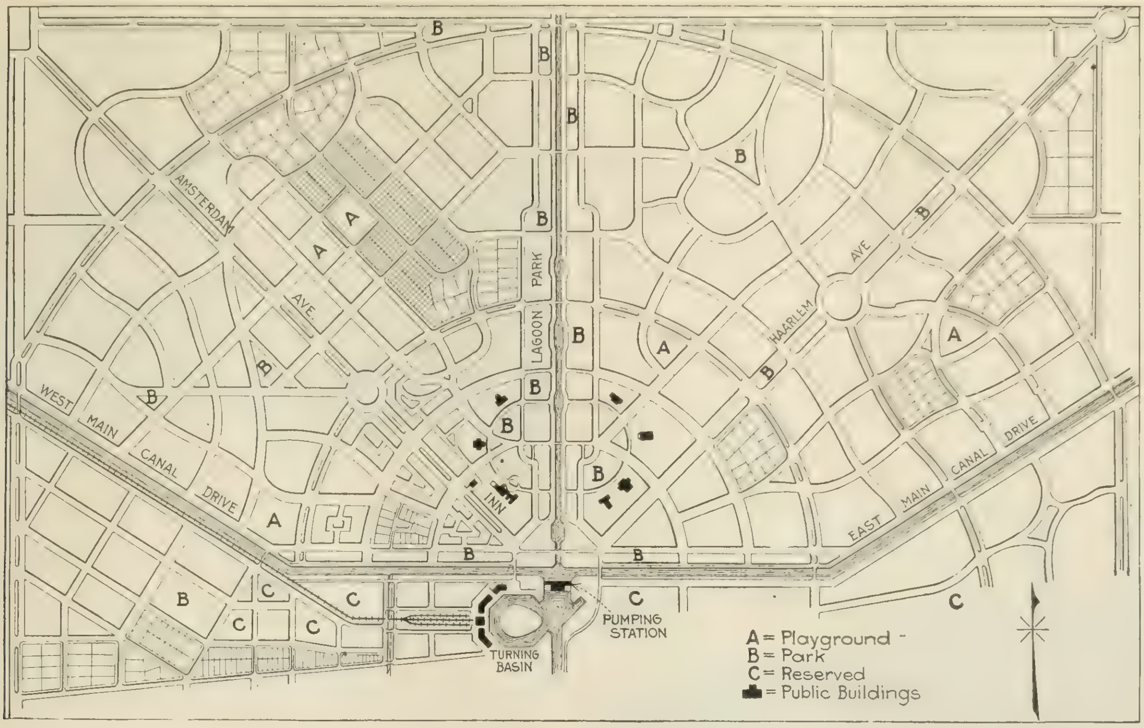


FIG. 3. PLAN OF TOWN OF NEW HOLLAND, N. C.

canal, an east main and a west main, with laterals running into these and all draining into a main sump 300x100 ft. in area cut to a depth of 13 ft. Immediately south of the sump and projecting over part of it was to be located the pumping station. The outfall canal was to extend from the station to Pamlico Sound. It was found that the difference of elevation between the sump and the canal normally would be 8½ ft., rising occasionally to 10½ ft. The total average rainfall for many years back has been 60 in. The climate is unusually mild, the highest temperature being in the vicinity of 93° F. and the lowest 8° F. above zero. Frosts commence in the middle of November and end with February. The total amount of water to be removed per year is 8,300,000,000 cu.ft. The pumping station was planned to have a capacity for passing 134,000 cu.ft. per min., or about 2200 cu.ft. per sec. At the pumping station are four 72-in. centrifugal pumps, each driven by a compound condensing steam engine. The estimated evaporation and plant growth would use up about 40 in. out of the 60 in. total annual rainfall, leaving only 20 in. to be handled by the pumps, which could be done by working 54 days.

FIG. 4. VIEW DOWN OUTFALL CANAL

In the construction of the outfall canal over 900,000 cu.yd. of earth was excavated. For the 130 mi. of drainage canal inside the district the excavation amounted to 4,000,000 cu.yd. This excavation was made by floating dredges digging ahead of the canals in which they rode. The outfall canal was constructed large enough for transportation of freight and passengers and now constitutes the main entrance to the locality. A railroad has been projected, and the right-of-way has been graded.

FIG. 5. NEW HOLLAND INN, ERECTED AT TOWN SITE

The maintenance of the canals and the cost of operating the pumping plant and of conducting the drainage district as an organization are raised by taxation and are expected to total about 25c. per acre per year.

Large Rural District Laid Out

The 50,000 acres of old lake bottom is now owned by the New Holland Farms, Inc., which has laid out a district into farms and towns, retaining for this purpose consulting agricultural and town-planning experts. The town of New Holland has been laid out surrounding the pumping station. There are three smaller community centers, respectively in the west, central and east sections of the district. In general, the roads are to fol-

low the canal banks, as shown in the accompanying sketches. The west and east main-canal banks furnish diagonal roads partly across the district, and north of these and generally parallel are a northwest and a northeast road. The smaller farms of about 5 acres each are laid out close to the town and community centers. Beyond these are the farms of 20 acres each and outside of these those of 120 acres. The lands of the company have been set aside as a separate township so that the people, whose lands are being developed separate from the older part of the community drainage district, may become a separate political unit and entirely control their own schools, roads, etc.

Each of the 120-acre farms has a frontage of 80 rods on a canal. About half of the canals will give light water transportation to the farm. Each farm will have a main

FIG. 6. NEW HOLLAND PUMPING PLANT

road laid out along the canal frontage. Each of the community centers will have its own post office, stores, church, school, assembly hall and playground.

The town of New Holland, which will be the main center for the whole district, has been laid out by H. P. Kelsey, landscape architect, of Boston. About 40% of the land in the town site has been set aside for parks, boulevards, roads, and sites for public buildings. The latter are located about a central space near the present pumping station. The New Holland Inn, shown in Fig. 5, is the first one of this group of buildings to be put up. It is of concrete, with tile roof, and has been made a much more pretentious structure than the locality at present requires, that it might serve as a model for the future buildings of size.

On account of the very flat area occupied by the town site the only topographical features that could be seized on for the landscape effects were the canals; these have been utilized as much as possible, as will be seen from the accompanying sketches. Roads and parkways line the canal through the town. The main central canal has been expanded into basins at various points for boating and amusements. The business district of the town is to be concentrated in the point of the northwest quadrant between the west and central canals. Outlying (northwest) from this are the smaller town farms, and beyond these the residential farms, extending to the limits of the town site. East of the central canal are the larger residential plots, these growing in size as the distance from the center increases. The southwestern quadrant is reserved for colored people. Provision has been made for a railroad coming in alongside the west main canal to a station and freightyard close to a turning basin, which is planned for ultimate excavation southwest of the pumping station.

The land company has engaged to set aside, out of the proceeds of sales, $100,000 to be spent for building and planting roads, boulevards and parks, for bridges, schoolhouses, community centers, permanent public buildings, etc. The company has also agreed that $100,000 shall be set aside out of the sales as a permanent endowment fund for variously promoting the welfare of the district—for arousing interest in agricultural developments, for maintaining the parks and playgrounds, for beautifying the locality, providing lectures and other entertainments and for hiring a social secretary.

The older land around the lake has been selling for from $100 to $175 per acre. The new lands scale down from those figures. A half-million dollars of 6% bonds of the district has been issued at par, one-tenth to be redeemed each year beginning with 1916, the sum required being provided by taxation against all the lands in the district, rated in accordance with the benefits received. This money has been spent, approximately $200,000 for the pumping plant and $300,000 for the canals, amounting to about $5 per acre average expenditure, compared with an average price of about $13 for such work elsewhere in the country.

The members of the Mattamuskeet Drainage Commission are D. N. Graves, of New Holland (also president of the New Holland Farms); David H. Carter, of Fairfield; and J. S. Mann, of Raleigh. The engineer for the district is Lawrence Brett, of Wilson, N. C., and E. M. Chapple is resident engineer.

Largest Drainage Pumping Plant Is at Mattamuskeet

The pumping plant built at New Holland, N. C., for unwatering Lake Mattamuskeet and for draining the lake bed of rainfall is believed to be the largest single drainage station, as well as one of the most interesting plants, built in this country for such work.

The station is a steel-framed brick structure, 76 ft. 9 in. wide (over roof) and 205 ft. 9 in. long, resting on a concrete substructure and pile foundations. It consists of a 205-ft. 9-in. by 34-ft. 8-in. engine house and

FIG. 1. BOILER HOUSE AND DISCHARGE BASIN.

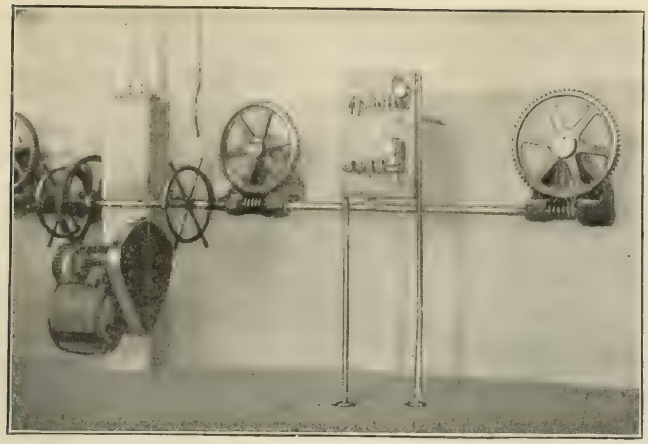


FIG. 2. OUTLET-GATE CONTROL, MATTAMUSKEET

a 108-ft. 10-in. by 45-ft. 8-in. boiler house adjoining, as shown in Fig. 4. Inside are four 850-hp. cross-compound steam engines driving four 72-in. quadruplet double-suction centrifugal pumps, each capable of delivering 36,000,000 gal. per day (560 cu.ft. per sec.) against a head of 8½ to 10½ ft.

Station Structure and Substructure

The structure that houses the boilers and pumping units is shown in its details by Fig. 4. There is nothing unusual about the superstructure—13-in. brick walls with steel columns buried in pilasters supporting each roof truss and the crane runway. Window openings have steel sash. The roof is covered with concrete tile. The boiler and engine rooms have one roof ventilator each; the boiler room has a ventilating space of 12 in. between side walls and roof sheathing.

The substructure is of interest, showing economy of concrete and separate foundations for machinery, boilers, stack and wall footings. The underlying soil consisted of layers of sand and mud down to 20 ft. depth, where sand and shell was struck. Cypress piles 8 in. by 27 ft., were driven to 5-ft. penetration of the sand-shell stratum for all the foundations (at which depth the *Engineering News* formula gave 40,000 lb. safe load), and the tops were embedded in the concrete footings.

The substructure forms a dam with 8½- to 10½-ft. head of water against it, that being the level between the outfall basin and the intake sump. The foundations and footings had to be designed to withstand side load as well as vertical. Instead of making the south (outfall) wall of the boiler room of heavy gravity section, able to withstand overturning, it was kept an 18-in. concrete wall, but it was braced on 16-ft. 4-in. centers by 8x10-in. reinforced-concrete struts going to the boiler foundations and by other struts going from the boiler foundations to the 20x30-in. columns of the middle wall. The connection of every other pair of struts to the boiler foundations was made by 15x16-in. and 12x16-in. beams, as shown in the details of Fig. 4. There is no connection to engine foundations. The stack is a separate reinforced-concrete structure 230 ft. high. The dock walls on either side of the boiler house are anchored to the two discharge pipes pasing through them; these pipes are independent of the boiler-room wall.

Pumping Equipment

The pumping units are the largest centrifugal machines yet built—having a capacity of 560 sec.-ft., or 250,000 gal. per min., or 360,000,000 gal. per day, thus equaling the huge New Orleans screw pumps. While properly spoken of as a single mechanical unit, each one of these pumps is in its hydraulic design four single-stage double-suction pumps working in parallel between two suction tubes and two discharge pipes.

These four runners are mounted on one shaft coupled between the high-pressure and low-pressure sides of a cross-compound condensing Lentz poppet-valve engine.

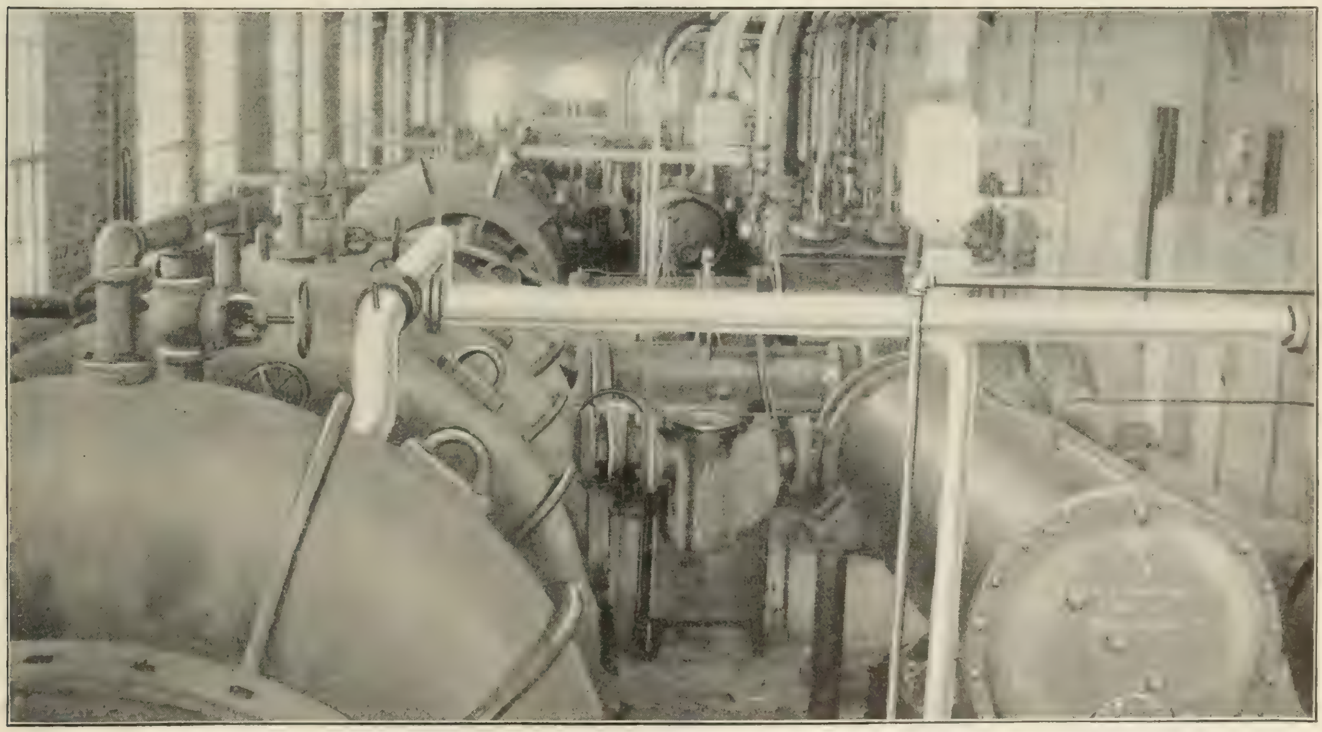


FIG. 3. ENGINE ROOM OF PUMPING STATION, MATTAMUSKEET DRAINAGE DISTRICT

Each engine is rated at 850 hp., having 21½ and 36x 27-in. cylinders, running at 170 r.p.m. and taking steam at 175 lb. gage and 250° superheat. A 10-in. pipe 31 ft. long crossing underneath the floor from high-pressure exhaust to low-pressure intake serves as the intermediate receiver. The final exhaust goes down under the floor through a gooseneck and comes up under a surface condenser located close to the main pumps. An 8-in. water line is led off the casing of one of the parallel stages of the main pumps through a strainer to furnish cooling water which is returned to the main-plant sump. The condensate is taken off to feed-water heaters by a small reciprocating pump on an extension of the vacuum-pump piston rod. The boiler feed pumps (two) are in the middle of the boiler room close to the feed-water heaters. Makeup pumps in the engine room draw from driven wells outside the boiler house (or from the main sump) and deliver to the feed heaters. A small high-

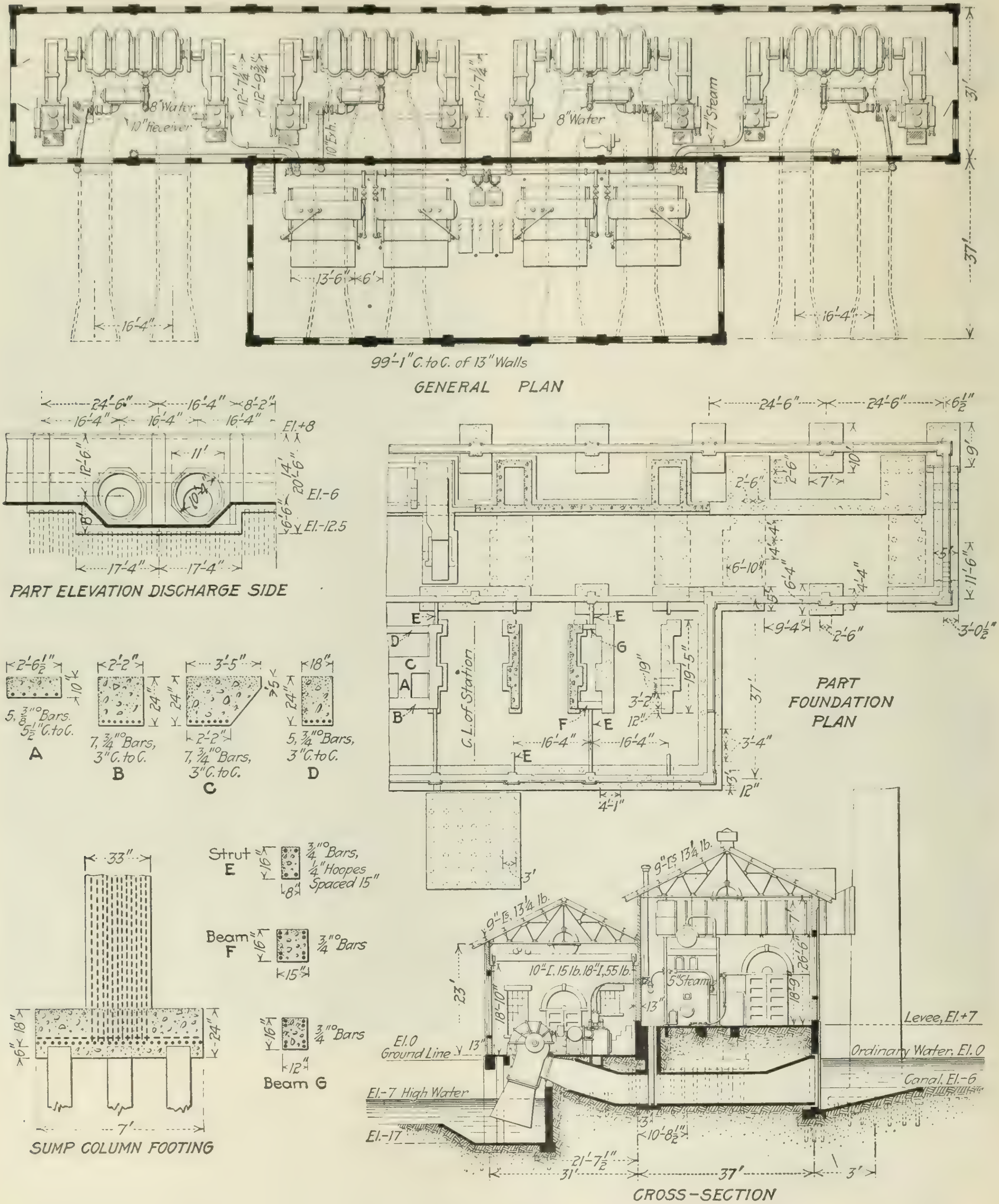


FIG. 4. CONSTRUCTION DETAILS OF MATTAMUSKEET PUMPING STATION, NEW HOLLAND, N. C

speed 25-kw. turbine-driven unit furnishes light and power for the station service. The auxiliaries exhaust to the feed-water heaters.

A gate well is built into the concrete outlet pipes just south of the engine-room wall. This has gate grooves and stop-log grooves. The gates are heavy timber slides, solid in the lower third and a simple but stiff truss for the upper thirds. They are lifted by racks on each edge, engaging pinions on short shafts going through the engine-room wall, where they end in large gears driven by worms on countershafts. One shaft is provided for each pair of gates belonging to one pumping unit. Each shaft is driven by a 10-hp. direct-current motor, but it can be hand operated. One of these shafts is shown in Fig. 4, together with the worm gearing, handwheels and the starting panel for the four gate motors.

The pump suctions are built of steel plate and are bolted to the suction castings of the pumps. Steel pipes bedded in 6 in. of concrete connect the discharge opening of the pump to the concrete discharge pipe leading under the station to the outfall canal basin.

The space between the piers supporting the north wall of the station is screened with 2¼x¼-in. steel rods spaced 2¾ in. apart, serving as a trash rack, which may be entirely removed without diving.

In the boiler room are four vertical-type steel-case water-tube boilers, each equipped with a superheater. The pipe and pipework follow common practice, except that forged steel headers and nozzles are used, steel valves with nickel seats, steel separators and traps designed for superheated steam. There are two 800-hp. open feed-water heaters taking the condensate before it goes to the hot well and employing the exhaust of the auxiliary pumps and turbine generator.

The main pumps were built by the Morris Machine Works, of Baldwinsville, N. Y. The Lentz engines were designed and built by the Erie City Iron Works, which also furnished the boilers. The condensers and condenser pumps were made by the C. H. Wheeler Manufacturing Co. The station was designed by Thomas B. Whitted, of Charlotte, N. C., representing the Morris Machine Works, assisted by H. C. Tripp, T. C. Heyward and the engineering department of the Morris company. The contract was let by the drainage district to the Morris Machine Works, and H. C. Tripp became the resident engineer for the contractors. The engineer for the district is Lawrence Brett, of Wilson, N. C., and E. M. Chappel is the resident engineer.

Engineer-Referee Supervises Drainage

In a paper before the Minnesota Surveyors and Engineers Society, E. G. Minder, an engineer serving as referee in ditch matters of the thirteenth judicial district of Minnesota, described methods of handling the work in his district.

Under the laws of Minnesota a judge having considerable ditch work under his jurisdiction can appoint a referee, and this referee can employ the necessary clerks for compiling such detailed accounts of the work, cost data, etc., as the judge may require. The purport of the law is to provide for an exact accounting for the people interested in the ditch and for the public examiners' accounts. By appointing a civil engineer to this position the judge provided his district, in reality, with a supervising engineer, and it was in this capacity that the referee rendered his principal service.

The present method of providing engineering services for drainage is to appoint an engineer who is recommended by the people interested in the ditch. During the past year Mr. Minder has had some ten engineering organizations reporting to him. A system was devised for getting daily report cards from each party, giving the name or number of the ditch, date, names of the men in the party, occupation, rate paid, expenses and total expenses and also the work accomplished each day. This work is done in the office of the referee, who personally spends considerable time in examining the proposed ditch in the field and checking the design and estimated cost as submitted by the engineer in charge and making a report to the judge.

To expedite this work, Mr. Minder has reduced computations of the flow of water in tile and open ditches and the estimated costs to curves plotted on coördinate paper. The capacities of the various sizes of tile and open ditches can be determined in the terms of acres of watershed for any desired hydraulic grade and run-off coefficient, directly from the plotted curves. From average experience curves have been prepared which show the cost of digging, laying and filling for the various sizes of tile and depths of ditch. From the current prices of tile and the average cost of hauling, a chart is made on which is shown, in the form of curves, the cost of tile delivered at the job for different lengths of haul up to 20 miles.

In checking the design, the data of a ditch are set forth on a drainage sheet in tabular form. On this are shown the sections of the ditch, the hydraulic grade, the velocity of flow, the acres of watershed, size of tile required and capacity of tile chosen. The drainage areas are measured from a scale map with a planimeter.

In the matter of inspecting ditches during construction there was some difficulty experienced in providing competent inspection on small ditches at a cost that was not prohibitory. This difficulty was overcome by grouping the ditches, whether judicial or county, according to location and assigning one inspector to each group.

If all the work that comes up in the district were assigned to one organization instead of divided among ten, the volume of business would permit the employment of men particularly fitted for each of these branches. These men would receive the pay that is due them for the class of work on which they are employed and no more. Engineering on drainage work would then be raised to a much higher standard degree of skill and efficiency, at a lower cost than is possible under present conditions. Men could be employed on work that is of general benefit to all drainage in the district. Each ditch would then receive the benefit of high-grade skill at a reasonable cost. Continuous employment would be assured, to a large part of the organization at least.

An organization that would realize the benefits and economies which are possible in carrying on a large volume of business would probably be divided into locating and construction departments and the office force.

In case contracts for furnishing tile were let directly to the manufacturers the inspectors assigned to work at the tile factories would be expected to oversee the proper shipment of tile besides attending to their other duties of inspection and testing.

Features of a City Viaduct Over Railway Tracks

The problems of solid-floor construction under conditions of minimum clearance and depth and protection from locomotive gases were the chief factors in the design of the Himrod Ave. viaduct in Youngstown, Ohio. The existing steel-truss viaduct here, which connects East Federal St. with Himrod Ave. across a wide belt of railway tracks, is seriously corroded and has been dangerously weak for some years. The city and three railways were interested in its renewal, and finally by agreement of all parties the design and construction were turned over to the New York Central Lines West, which pays the largest share of the cost.

Ample experience with solid-floor construction was furnished by the Chicago street crossings built by the Lake Shore & Michigan Southern Ry. in its track elevation eight years ago. These have reinforced-concrete slab floors resting on either longitudinal or transverse I-beams, and up to now have remained perfectly tight, showing no cracks, seepage or local staining, in marked contrast to neighboring crossings with concrete-filled trough flooring. The same construction was therefore applied to the Himrod Ave. viaduct, with the addition of concrete incasement for all steel exposed below the floor.

The difficulties of grade and clearance conditions can be seen from the general drawing, Fig. 4. To avoid excessive grades the floor had to be made as thin as possible. Two different floor arrangements were made necessary by the layout of supports, which called for a skew plate-girder span of 113 ft. (with intermediate post on one side) and a series of short spans on which longitudinal I-beams could be used. The floor on the plate-girder span rests on transverse I-beams spaced 8 ft., while the floor on the short spans rests directly on the longitudinal beams, partly embedding them. Fig. 1 shows both floors in some detail.

Depressed troughs are formed to receive the street-car track construction. Steel spacer ties and concrete ballast

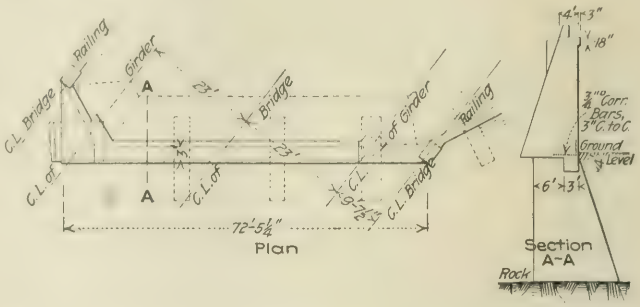


FIG. 2. INDIVIDUAL PIER FOUNDATIONS OF ABUTMENT CARRIED TO ROCK

will be used for the track, giving a level concrete foundation for the wood-block surface.

The beam-span floor with its integral parapet forms a complete concrete trough, but in the plate-girder span

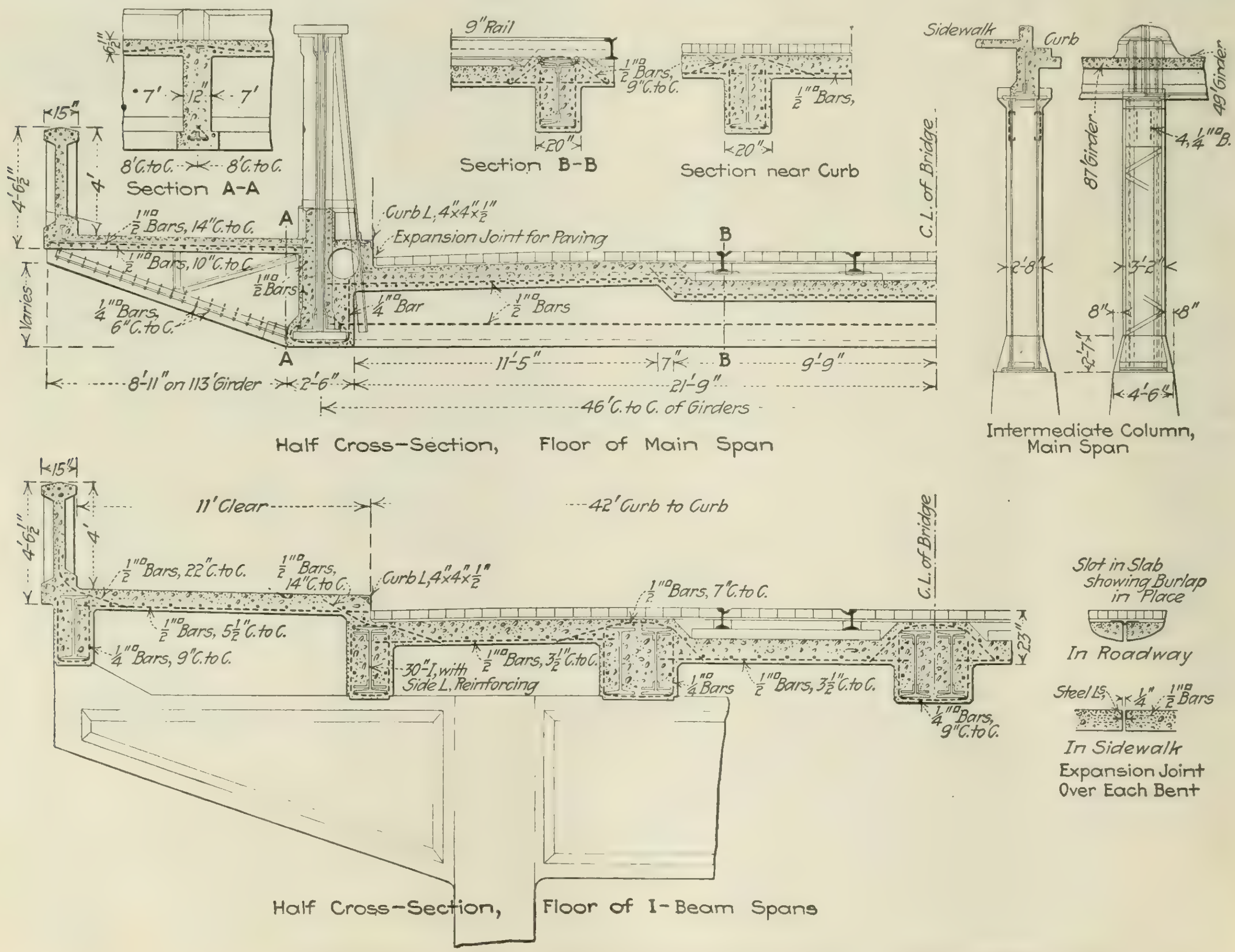


FIG. 1. TWO REINFORCED-CONCRETE SLAB ARRANGEMENTS, USED IN THE VIADUCT FLOOR

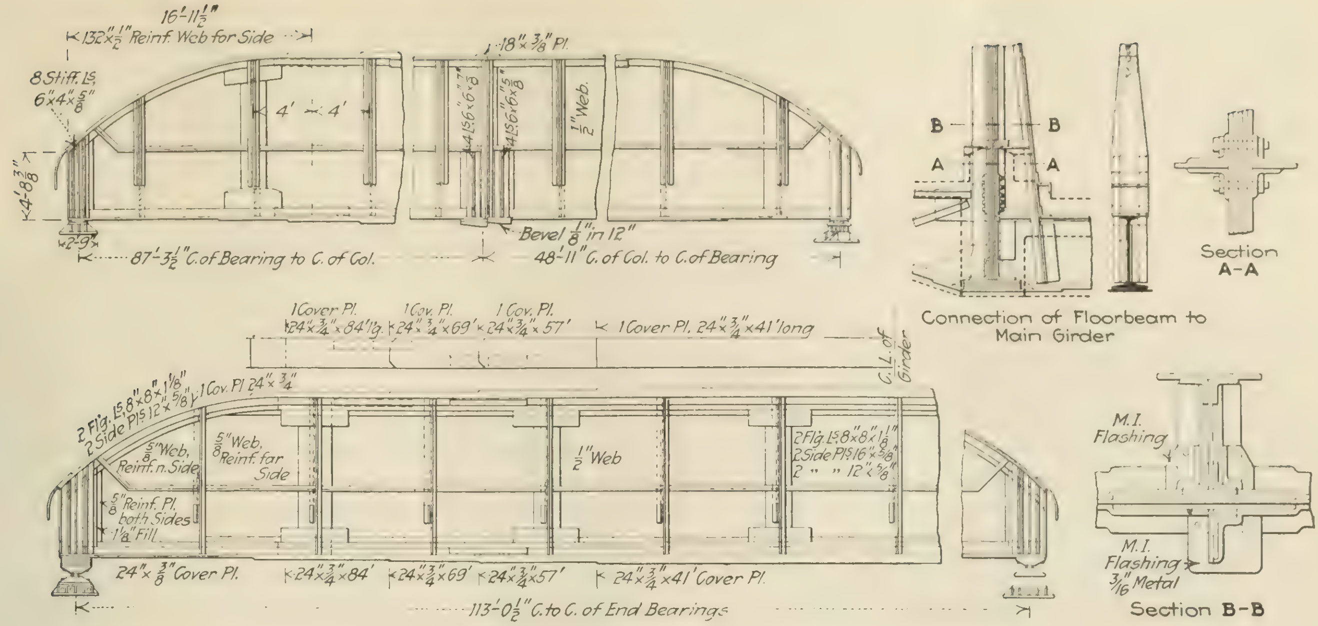


FIG. 3. DETAILS OF LONG-SPAN PLATE GIRDERS

special detailing was necessary to secure such a trough. A longitudinal angle riveted to the girder web (Fig. 3) forms a finish ledge against which is joined the concrete carried up along the side of the web. The finish angle is continued around the stiffeners of the girder by small malleable-iron castings.

The steel bents supporting the beam spans are incased in concrete, as indicated in Fig. 1. At only one point was sufficient width available to permit using a concrete bent. All incasement is strengthened and tied in by rods. Mesh was avoided, as making it difficult to secure solid concreting.

Some features of the steelwork invite study. The beam spans involve bending moments large enough to make even double 30-in. I-beams inadequate at the car tracks, without flange reinforcement. In place of flange plates, commonly used for such reinforcement, 7x3 ½-in. side angles are used, riveted to the web directly under the beam flanges.

The plate-girders of the long span have the top flange curved down at the ends, for the sake of appearance. As this reduces the shear section of the web, reinforcing webs are riveted to the end portion.

The manner of attaching the floor beams and the construction of the top flange braces are shown in the drawing. The sidewalk bracket is fastened at its upper edge by bolts, which transmit the cantilever tension through the girder web to the brace on the inner side.

One of the two girders could be supported by an intermediate post; and the girder is therefore made in two sections, although the opposite girder is a single span. Where the girder sections join over the post, they are butted squarely and are lightly riveted together through the outstanding legs of the abutting stiffener angles. The top flange has a small cover-plate, but slotted holes prevent the transmission of bending moment.

The two girders are a unit with respect to expansion, a roller bearing being placed at one end. The bearings depend on simple beveled rocker plates for flexibility, whereas the long girder has pin-bearing shoes.

One of the abutments of the viaduct shows unusual construction because of the foundation conditions. Rock is

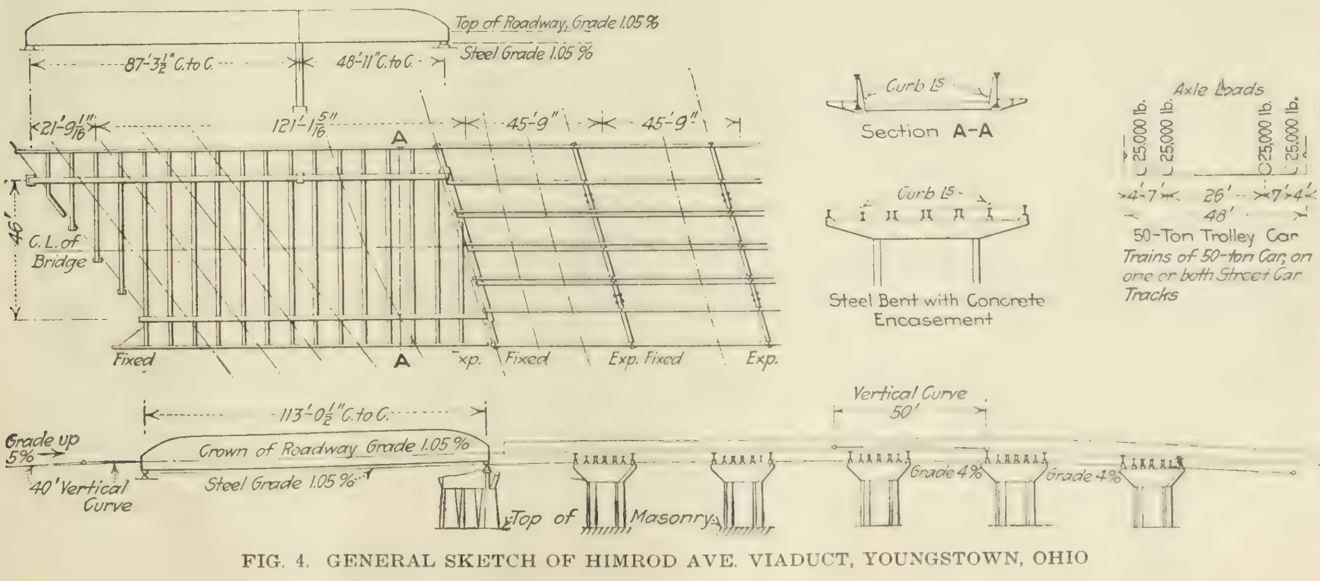


FIG. 4. GENERAL SKETCH OF HIMROD AVE. VIADUCT, YOUNGSTOWN, OHIO

only about 25 ft. below ground surface, and with a view to future depression of tracks it was thought safest to carry the abutment down to rock. The difficulty and cost of going down with the entire base of the abutment close to a creek channel led to the expedient of carrying down only isolated piers, the abutment spanning across these piers. Fig. 2 sketches part of this abutment.

The design was made under the direction of B. R. Leffler, Bridge Engineer, New York Central Lines West, Cleveland, Ohio.

The Art of the Expert Witness

(Contributed)

SYNOPSIS—An answer to the question, "Why do engineering experts' opinions differ, particularly in valuation matters?" The cause is traced to differences in basic hypotheses which the opposing attorneys place before their respective experts. Complementary to a previous article on the good presentation of expert testimony.

II. When Experts Differ

In a previous article the writer offered some suggestions, based on experience, for increasing one's efficiency in the presentation of expert testimony. In the present paper it is proposed to turn aside from that phase of the art of the expert witness to comment on one aspect of expert testimony that apparently is attracting much attention.

Briefly, why is it that the opinions of experienced and qualified engineers and other experts on technical matters often differ so widely? One not infrequently hears the opinion expressed that this difference necessarily implies dishonesty or at least lack of candor on the part of one side or the other. Again, there is a certain group of persons, not a few lawyers among them, who hold that the wide difference of opinion among experts is a very pernicious matter, that it is due to the cupidity of the experts, and that experts as a class are dishonest and unreliable.

A litigation primarily involves a marked difference of opinion between the two sides, otherwise there would be no litigation. Looking at the situation broadly, is it more inconsistent that engineering, or medical or other experts, should differ in their opinions on complex and often uncertain questions than that the attorneys of their clients should so differ?

In Valuation Cases

Differences of opinion between opposing engineering experts become especially noticeable in valuation cases. It is possible to inflate the valuation of a property to any multiple of its real value, but it is only possible to depreciate it to zero or 100% less than its first value. Therefore, it is evident that abuses arising from this practice are more obvious, although ethically no less pernicious, when appearing on the high than when appearing on the low side.

There undoubtedly are among engineers so-called experts who are willing, in answer to hypothetical questions, to put almost any valuation an attorney or client may desire on a property. It is not too much to say that unscrupulous experts are enabled to remain in practice largely because some lawyers hire them—sometimes unwittingly, sometimes with intent.

This is not a mere abstract theory; in one city a self-styled engineer, rejected for membership in a leading engineering society, has been retained many times during the last few years as an expert on technical cases, his engagement always emanating from the attorneys. Not once, so far as known, has he been called upon to collaborate by reputable engineers.

Even where the experts are fair-minded and capable, wide differences of opinion in valuation occur. The question arises: Who is to blame for these apparent abuses in valuation cases? These troubles are not confined to engineers. They are at least equally common among real-estate men, among merchants acting as witnesses in the valuation of merchandise, and among farmers in the valuation of crops. Apparently then, exorbitant and deficient valuations under oath must result from some inherent defect in the methods of court procedure.

Hypotheses the Fault

Valuations are mostly opinion evidence. They are sworn to not as absolute facts but as opinions. In general, they are in response to some hypothetical question describing in more or less detail the elements of value of the property being valued. The opinions given are or should be in accordance with the hypothesis assumed. Herein lies the cause of most of the differences among experts in physical valuations.

A recent Los Angeles case has been cited as illustrating the wide differences among engineers in valuations.[1] The valuations presented by the opposing sides are quoted as follows:

		Company's Estimate	City's Estimate
1.	Cost of Physical Property:		
	Historical reproduction, less depreciation	$4,200,000	
	Reproduction new, less depreciation	....	$3,473,803
2.	Going concern or franchise value	5,187,623	Not given
3.	Bond discount, etc	380,340	Not given
4.	Damage by isolation of substation	416,000	Not given
5.	Expense of rebuilding transmission lines	1,000,000	Not given
6.	Severance damage	10,706,103	414,035
	Total	$21,890,066	$3,887,838

Mr. Cooke intimates that there is something highly iniquitous in these results and that it will be difficult "to make progress in building up a sound and just utility policy in this country so long as this kind of a result is considered to be the legitimate outcome of valuation engineering."

Now the writer knows of the case referred to only from Mr. Cooke's article, but the figures themselves indicate clearly that the difference was mainly one of hypothesis, for which the attorneys and not the engineers were responsible. The two valuations of the physical property are not wide apart, considering that here again is a difference of hypothesis, one being for historical reproduction, the other for reproduction new as of date of

[1]"An Open Letter to Engineers," by Morris Llewellen Cooke, "The Utilities Magazine," July, 1916.

the valuation. The city's experts evidently worked on the hypothesis that items 2, 3, 4 and 5 did not exist or were not involved. Had they assumed, for example, that transmission lines were to be rebuilt physically identical with those assumed by the company's experts, there would necessarily have been some value under item 5 in the city's estimate.

This example will illustrate a common experience that opposing engineers may agree closely as to actual physical value and reproduction cost, and yet their gross valuations under different hypotheses as to intangible and other disputed elements may throw the resulting valuations wide apart. The fault in such cases lies largely in the present unsettled and unsatisfactory state of judicial procedure in valuation cases, but little less with the attorneys, and only to a minor degree with the engineering experts themselves.

In framing a hypothetical question, the attorney for the plaintiff construes questions of doubt in favor of his client, and no doubt properly so. On matters where the law is in dispute—and there are many—the attorney assumes that the court will rule in his favor, assumes a state of law favorable to his client in framing his hypothetical questions and advises his experts accordingly. The opposing attorney with equal propriety construes these same questions of doubt oppositely. Thus it seldom happens that the foundation for the hypothetical questions is the same on both sides, and the answers accordingly should, and indeed must, be different.

On cross-examination, the expert who has answered a hypothetical question is very likely to be asked if his opinion would have been changed had he made the same set of assumptions which were made in the hypothetical question covering the same set of facts as presented by the opposition. Such questions usually bring out little of real value. The reason will appear. The expert who has given long and careful study to a situation in order to formulate his opinion on a certain assumed set of facts is practically incapable of giving, at a moment's notice, the opinion which he would have held if the given set of facts had never been before him at all, and an entirely different and somewhat opposite set of facts had been given an equal amount of study. In other words, the fundamental reason for differences in opinion is, in general, differences in the complex of facts and conditions on which the opinions are based.

A Chance for Improvement

While it is undoubtedly true that an expert in any capacity should not assume the rôle of advocate, yet it is equally true that under existing methods of court procedure, for which the legal and not the engineering profession is largely responsible, the engineer-expert must in fairness to his client largely construe questions of doubt in his client's favor. In any event, he will often be forced to do so by the attorneys, by virtue of the form of hypothetical questions used.

It is not to be disputed, however, that there is room for very material improvement in the technical character of expert testimony. In the majority of cases there is no reason why there should be any real or material difference in the estimates of opposing experts in such a matter, for example, as the average rainfall over a given drainage basin where both sides have derived their estimates from rainfall at the same stations and for the same periods. The great engineering societies should, through committees, establish and promulgate so far as possible standard methods of engineering practice on a wide variety of subjects not now standardized.

The subject of hydraulic and hydrologic calculations especially offer inviting opportunities for such standardization of practice. It can be shown, but limitations of space forbid its presentation here, that there is one and only one solution of each of a wide variety of hydrologic and hydraulic problems which meets the test of using all the available information in the best manner possible. If, where practical, standard methods in engineering practice and in computations are adopted which meet this requirement, then opposing experts, working from the same data, will reach the same results much more frequently than at present; because, in a given case, an expert would either use a standard method as a basis for his computations, or he would subject himself to the necessity of giving adequate reason for failing to do so.

Partisan Versus Neutral Experts

Because of the difference in opinions prevailing among experts, some have held that present methods of procuring expert testimony should be done away with, and that instead, when the court requires expert advice, it should secure it independently of either of the parties to the action. The writer does not see any great benefit in that scheme. The present method procures for the court in general a perspective view of the full range of conditions involved. Substitution for this of a system of experts in the employ of the court would in general procure for the court only a limited exposition of the conditions involved. There is hardly an expert who has not had his own view of a subject broadened, his knowledge increased and his ideas clarified as the result of the presentation of the opposite aspects of the subject by opposing experts.

The body of the law itself as it stands today represents the crystallized experience of centuries past. Judicial procedure by virtue of its nature cannot be modified in advance to meet changing conditions. A system of aërial jurisprudence could not well precede the development of the aëroplane. The railroad and steamboat were precursors of modern transportation law. The engineer on the other hand is the advance agent of material progress. By his foreknowledge he should be able to aid greatly in establishing right precedents at the start, in matters of legal procedure involving new conditions. But in order to secure the recognition he deserves in shaping matters of new jurisprudence, the engineer must first train himself to perform the functions of an expert witness in an efficient manner.

The New York City Death Rate for 1916 was 13.89. This was the lowest death rate on record, notwithstanding epidemics of influenza, infectious colds and poliomyelitis—the latter causing 2448 deaths and giving a rate of 0.44 per 1000. As recently as 1900 the total death rate was 20.57. In 1910 it had fallen to 16. Since then the figures have been: 1911, 15.3; 1912, 14.41; 1913, 14.21; 1914, 14.03; 1915, 13.93; 1916, 13.89. From 1910 to 1916 there have been reductions in infant mortality from 125.6 to 93.1 per 1000 births reported; in typhoid fever, from 0.12 to 0.4 per 1000 population; and in tuberculosis, from 1.81 to 1.5. Measles, scarlet fever, diphtheria and croup declined materially from 1910 to 1916, but whooping cough showed little change. There have been material increases in organic heart diseases, Brights' disease, nephritis and cancer during the past seven years. The actual number of deaths from typhoid was 558 in 1910 and only 215 in 1916. The population of the city in 1916 is estimated at 5,602,841.

Crack in New Concrete Arch Explained by Freezing of Pocketed Water

By A. W. Zesiger*

SYNOPSIS—One rib of a 145-ft. concrete-arch span cracked nearly through. Attempts to explain the crack as being the result of arch stresses did not give a plausible result. A pocket of porous concrete found in the arch at the crack contained water, and freezing of this water in the winter of 1915-16 is thought to have split the arch.

The news items of *Engineering News* of Aug. 3, 1916, contained a short article concerning the appearance of a crack (see Fig. 1) in one of the arch ribs of the Detroit-Superior Bridge at Cleveland, Ohio. There was nothing contained in the article ascribing a cause that might have produced this crack, although, indeed, a very perplexing problem was presented to anyone who attempted to explain why it occurred at that place and what caused it to follow an almost horizontal direction instead of following a plane normal to the linear arch.

Porous Pocket Found in Interior of Concrete

A section of the arch rib was cut out, after the load of the arch had been transferred by means of 122 five-ton screw jacks to the steel arch centering replaced under it, and at the time the article in question was written all indications were that the concrete was of good quality. However, when the work of cutting out had progressed far enough to reach the horizontal crack, there was discovered a pocket 21 in. wide and 42 in. long of honeycombed material following the plane of this crack.

In order that conditions at the time the crack occurred may be more fully understood it is necessary to give the actual sequence of construction. It was originally intended that the work of construction should start at the easterly end of the steel span (Fig. 2) and progress easterly. This, however, could not be done, because the erection of the 591-ft. span across the river was begun by the King Bridge Co. simultaneously with the construction of the arch ribs by the Hunkin-Conkey Construction Co., contractor for the concrete superstructure. It was decided therefore to begin with the second arch east of the steel span—that is, the arch between Piers 5 and 6, and progress easterly therefrom. This produced considerable eccentricity on Pier 5, but calculations predicted that the soil pressure was within safe limits.

The arch rib in which this crack developed was the first one constructed, having been poured May 27, 1915. Careful observations were made of the settlement of all the piers, but Pier 5 was also closely watched with reference to any horizontal or tipping movements. On May 1, 1916, the crack in question was first observed.

Fig. 3 is intended to illustrate the sequence of the work. As will be seen, the arch ribs only were constructed between Piers 5 and 6, the arch ribs and first floor between Piers 6 and 7, continuing thus to increase the load the farther the work progressed from Pier 5.

Piers of Cracked Arch Rocked Under Unbalanced Loads

Before proceeding very far it was discovered that the top of Pier 5 was moving westerly, caused by the unbalanced load on the pier. The movement advanced to such a stage as to threaten the stability of the structure.

At this point the King Bridge Co. had lowered the steel arch into place and had released the backstays that extended from Pier 4 to Pier 5. The lower chords of

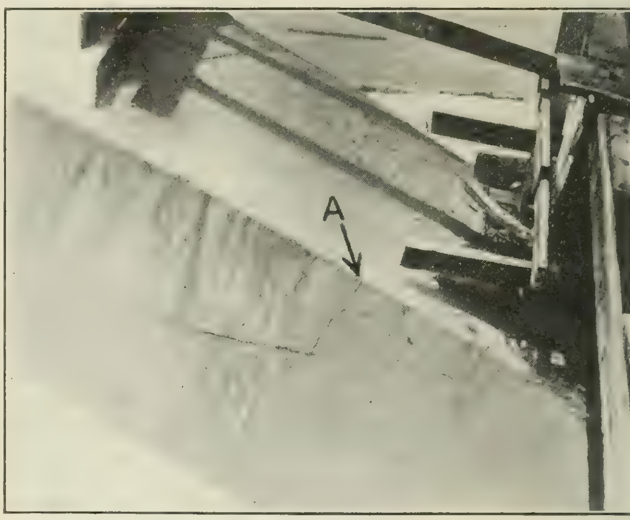


FIG. 1. VIEW OF CRACK IN ARCH 6, DETROIT-SUPERIOR VIADUCT, CLEVELAND

these stays consisted of strong lattice girders. It was decided to use these girders as struts between Piers 4 and 5, and by so doing prevent any further movement of the latter pier.

Movements in Pier 6 were discovered proceeding simultaneously with those of Pier 5. Therefore, after having placed these struts, the work of pouring the first floor on the arches between Piers 5 and 6 was begun, as it was thought best to increase the load on these arches. Observations indicated no further movement of

*Cuyahoga County Bridge Engineer, Court House, Cleveland, Ohio.

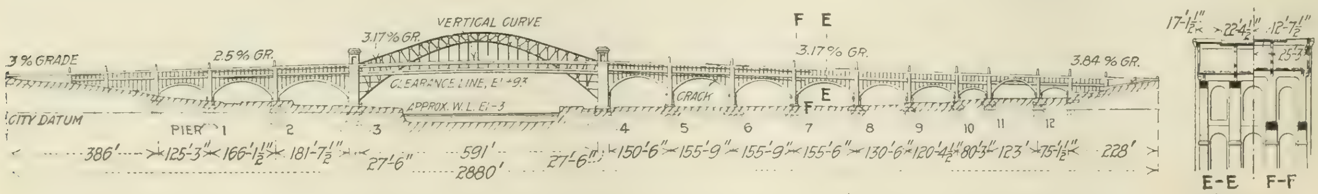


FIG. 2. SKETCH OF DETROIT-SUPERIOR VIADUCT, TO SHOW LOCATION OF CRACK

TABLE SHOWING MOVEMENTS IN PIERS 5, 6 AND 7

Levels on Pier 5

Settlements in feet; the four marks were near base of shaft, El. +6, and the E and W marks were 19 ft. 8 in. apart. Bottom of footing is El. —14

Date Loading	SW	SE	NW	NE	Movement to West
Apr. 1, 1915—Pier, El. 6 (since Dec. 7, 1914)	0.005	0.005	0.015	0.007	......
May 3, 1915—North pedestals El. 53.27, south pedestals av. El. 12	0.008	0.005	0.018	0.010	......
June 1, 1915—Pier, El. 53.27; span 6, north ribs	0.015	0.015	0.033	0.024	......
June 15, 1915—Pier, El. 53.27	0.014	0.017	0.042	0.026	......
Aug. 18, 1915—Span 6, four ribs; span 7, four ribs and columns	.....	.....	.....	.....	0.000
Sept. 4, 1915—Span 7, first deck part done; span 8, ribs and columns	0.031	0.020	0.059	Covered up	......
Sept. 15, 1915—Span 8, first deck part done	0.035	0.021	0.053	Covered up	0.042
Sept. 27, 1915—Span 7, lower deck done; span 8, lower deck part done	0.034	0.020	0.052	0.032	0.052
Oct. 7, 1915—Span 4, all trusses erected; span 5, nothing; span 6, all ribs; spans 7 and 8, lower deck	0.036	0.022	0.053	0.027	......
Nov. 17, 1915—Span 4, all trusses erected; span 5, nothing; span 6, all ribs; spans 7 and 8, lower deck	0.044	0.031	0.072	Bolt covered	0.052
Nov. 19, 1915—Span 4, all trusses erected; span 5, nothing; span 6, all ribs; spans 7 and 8, lower deck	0.044	0.031	0.072	Bolt covered	0.062
Nov. 20, 1915—Span 4, all trusses erected; span 5, nothing; span 6, all ribs; spans 7 and 8, lower deck	0.044	0.031	0.072	Bolt covered	0.073
Dec. 16, 1915—Pier to lower deck; center section span 6	0.046	0.031	0.072	Bolt covered	0.073
Mar. 16, 1916—Pier to lower deck; center section span 6	0.059	0.040	0.092	Bolt covered	......
May 8, 1916—Upper deck span 9, three ribs span 5	0.063	0.048	0.096	Bolt covered	0.073

Levels on Pier 6

Settlements in feet; the four marks were near base of shaft, El. + 7.5, and the E and W marks were 19 ft. 2 in. apart. Bottom of footing is El. —14.

Date Loading	SW	SE	NW	NE	Movement to West
Apr. 1, 1915—Pier, El. 7.5 (from Dec. 7, 1914)	0.002	0.000	0.006	0.011	......
May 3, 1915—North half, El. 50.25	0.005	0.006	0.018	0.021	......
June 1, 1915—Pier, El. 50.25; span 6, north ribs	0.016	0.019	0.028	0.047	......
July 3, 1915—Pier, El. 50.25; span 5, nothing; span 6, four ribs north outer and inner; two north ribs spans 7 and 8	0.020	0.023	0.032	0.052	......
Sept. 4, 1915—Pier to first deck; span 5, nothing; span 6, four ribs; span 7, first deck part done; span 8, four ribs and columns	0.053	0.046	0.063	0.070	......
Sept. 28, 1915—Span 7, lower deck complete	0.061	0.058	0.078	0.069	......
Nov. 17, 1915—Pier to lower deck; spans 7 and 8, lower deck; center section span 6	0.065	0.059	0.087	0.079	......
Dec. 16, 1915—Pier to lower deck; spans 7 and 8, lower deck; center section span 6	0.072	0.066	0.086	0.081	......
Mar. 16, 1916—Lower deck spans 9 and 10 and part of span 6; upper deck span 8	0.081	0.074	0.085	0.091	......
May 8, 1916—Upper deck, span 9; span 5, three ribs	0.087	0.083	0.104	0.101	......

Levels on Pier 7

Settlements in feet; the four marks were near base of shaft, El. + 10, and the E and W marks were 18 ft. 5 in. apart. Bottom of footing is El. —14.

Date Loading	SW	SE	NW	NE	Movement to West
Apr. 7, 1915—Pier, El. 10 (since Dec. 10, 1914)	0.013	0.013	0.016	0.010	......
June 6, 1915—Pier, El. 48+	0.011	0.015	0.014	0.024	......
Sept. 4, 1915—Pier to El. 63; ribs on spans 6 and 9; first deck on span 7; ribs and columns on span 8	0.042	0.049	0.051	0.052	......
Sept. 28, 1915—Pier to lower deck; ribs on span 6; lower deck on span 7 and part of 8; ribs and columns on span 9	0.061	0.064	0.060	0.059	......
Oct. 5, 1915—Lower deck on all of span 8 and part of span 9	0.058	0.069	0.067	0.063	......
Oct. 13, 1915—Part lower deck span 9 added	0.068	0.073	0.075	0.076	......
Nov. 24, 1915—Lower deck span 9 complete, part on span 6	0.079	0.087	0.088	0.089	......
Dec. 16, 1915—Upper deck on span 8	0.078	0.082	0.089	0.079	......
July 3, 1916—Upper deck, spans 8, 9 and 10; all lower deck and pier 7	0.098	0.099	0.103	0.102	......

Pier 5, but Pier 6 now began to move easterly. The accompanying table shows levels taken on the piers during the time in question. These figures, as well as the other data on which the calculations and conclusions are based, were obtained by K. D. Cowen, the county's resident engineer for the Detroit-Superior bridge.

The diagram, Fig. 4, gives equilibrium polygons for conditions resulting from the movements of the piers, as well as the force and equilibrium polygons for dead-load at about the time the crack occurred. In these graphics the bending moment at any point is the product of H times the vertical intercept between its respective equilibrium polygon and the neutral axis of the arch; H is shown positive when it tends to compress the arch rib and negative when it tends to pull it apart.

The values of H and V given are those that would result from the pier movements if the modulus of elasticity of the material remained constant throughout the entire distortive movements. Computations of stresses disclose that for a value of H of about 300,000 lb., the steel in some parts of the rib would be stressed in excess of 60,000 lb. per sq.in. It would thus seem that the values of H and V given on the diagram are very much in excess of those that actually resulted from these movements.

It is not pretended that the stresses given are exact, as this would not be possible; but it is believed that they correctly show the kind of stress, tension or compression, as the case may be, that existed in this region when the crack occurred.

Could Bending Stresses Produce the Crack?

It will be seen by referring to these equilibrium polygons individually as well as collectively that the bending moment is always positive at the place where the crack occurred; that is, the movement is such as to tend to produce tensional stresses at the intrados and compression at the extrados of the arch.

It is true that levels taken June 1, 1915, on the footings of Pier 6, indicate that the northerly end of this pier inclined easterly to quite a considerable extent. As there were no observations between May 27 (the time the rib in question was poured) and June 1, it is not possible to determine what portion of this movement took place before the concrete was set. However, if the movement had been sufficient after the concrete had set to rupture the rib at a place not reinforced, it would have been expected to occur at the lower end of the section containing no reinforcement. Inasmuch as no cracks were observed under close scrutiny, it would seem that rupture did not take place at this time, much less so at the point where the crack later was observed, as this place is almost at the point of contraflexure for inclinations of Pier 6.

The graphics, therefore, do not show any values of H and V for movements easterly of Pier 6, but a westerly inclination only, which was the inclination of this pier about the time that rupture was thought to have occurred.

It was thought, and even claimed by many, that the crack was caused by flexure that produced tension at the extrados, which resulted in a radial crack, and that when the crack reached the pocket of honeycombed concrete it followed along this pocket. This, however, could not have been the case, since, as stated above, all the forces acting on the arch at that place produced compressive stresses at the extrados. Had the crack occurred at the corresponding place on the opposite side of the arch, then it could have been explained as being a tension crack.

It was thought by others that it was a shear crack, a thing that seemed quite plausible except for the difficulty in explaining why any force of such magnitude as to shear the arch for about two-thirds its distance should suddenly cease to exist. In other words, if there had been acting on the arch a shearing force of sufficient magnitude to produce this crack, complete collapse would naturally have been expected.

Besides, the shearing stresses due to the dead-load were very small, even if the honeycombed area were subtracted from the total area of the section along a plane determined by this crack. This stress on the

section, reduced by subtracting the honeycombed area and also reduced by frictional resistance corresponding to 15° friction angle (a value that seems to be substantiated by tests), is a little less than 27 lb. per sq.in. From numerous tests that have been made it would appear that this is about one-ninth the ultimate strength of concrete of a similar quality. The natural conclusion, therefore, would be that it could not have been a shear crack.

It was suggested by some engineers that the steel struts between Piers 4 and 5 increased the horizontal thrust on the arch rib to a considerable extent, due to expansion caused by change of temperature, and that this thrust, combined with the dead-load thrust, sufficed to shear the arch rib.

Like all elastic bodies, the arch rib would be capable of resisting a thrust like the one produced by the strut in proportion to the amount of deformation, which in this instance would be the change of span caused by the movement of the pier, resulting from the expansive force of the strut against it. Since careful observations disclosed no movements, the movements must have been so small as to be not within the limits of the method employed in making the observations.

By referring to the graphics on the diagram, Fig. 4, it will be found that the arch rib would resist a horizontal movement of the pier of ¾ in. at the springing line of the linear arch by a horizontal thrust of about 300,000 lb. Since the methods employed for observing pier movements were sufficiently accurate to detect a movement of $\frac{1}{16}$ in., the horizontal component resisted by the rib must have been comparatively small — in fact, so small as to be negligible. Since the concrete, with the exception of the honeycombed section, was of excellent quality, it is plain that the crack could not have been caused by this small stress.

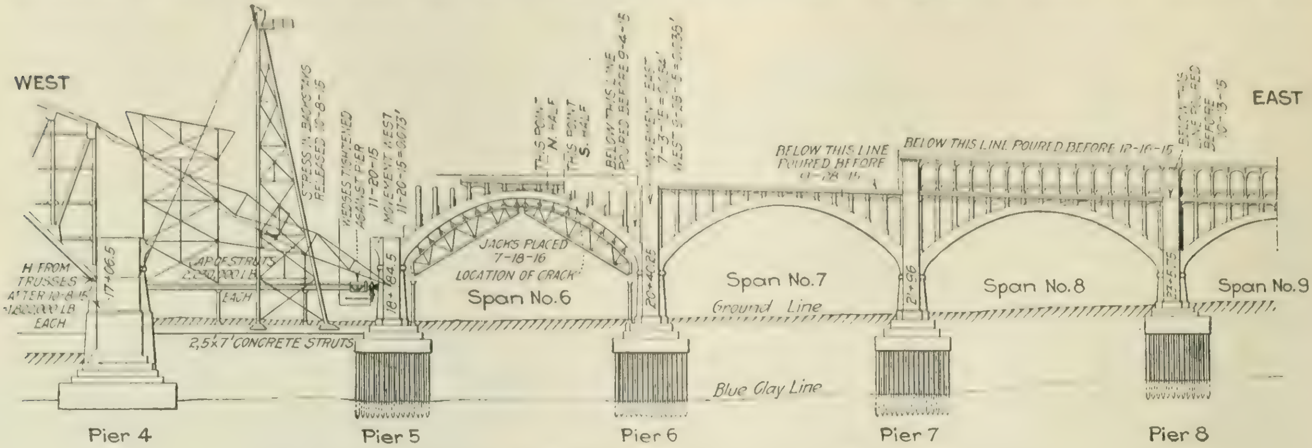


FIG. 3. CONDITION OF ERECTION AND LOADING OF CRACKED ARCH

Influence of the Honeycombed Spot

Reference to the diagram will show that there is no reinforcing steel at this portion of the arch where the crack occurred. Engineers generally expressed as their opinion that, had there been steel placed at this section, the crack would not have taken place. The writer, however, contended from the first that such was not the case and accordingly sought for some other cause.

The only cause that seemed at all probable was that the honeycomb had been formed by an excess of water in the concrete at the time of pouring, and the material, being improperly worked, did not allow the water to escape. This portion, being completely surrounded by concrete of good quality that permitted no evaporation

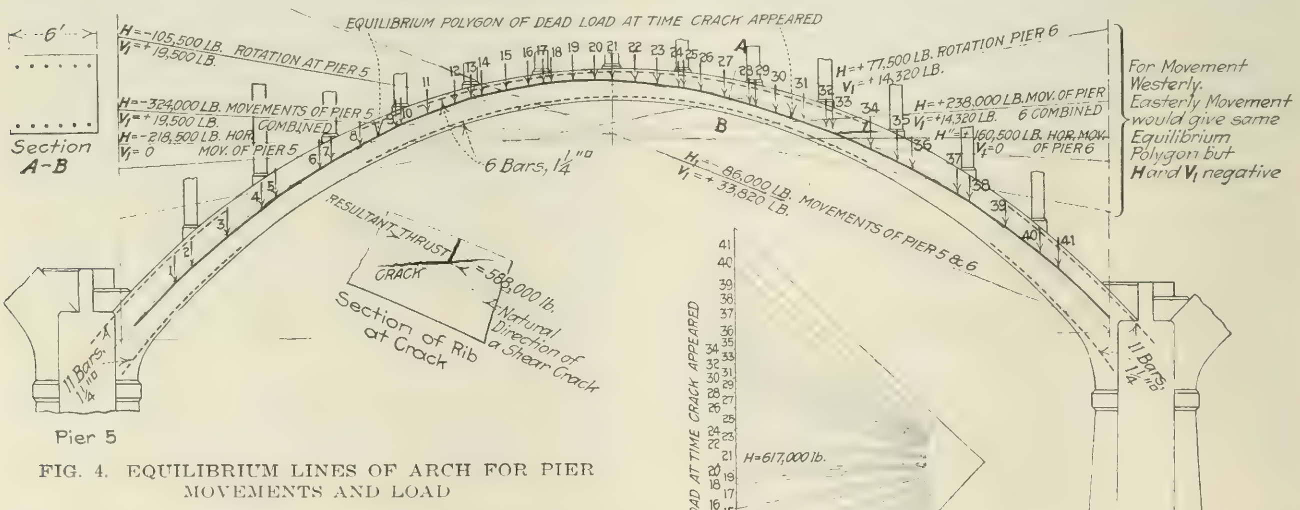



FIG. 4. EQUILIBRIUM LINES OF ARCH FOR PIER MOVEMENTS AND LOAD

of the water, remained so imprisoned until severe weather, when the extreme cold penetrated to the liquid, froze it and caused the crack.

The time that elapsed from the pouring of the concrete until its probable freezing was about eight months. While this may seem an unusually long period, it is the opinion of the writer that the above-mentioned condition was entirely possible, on account of the fact that the air which naturally had to replace the water would be obliged to enter through the same pores occupied by the water in evaporating.

The water was situated nearly in the center of the arch rib, at a distance of from 2 to 3 ft. from the surface, and considerable time necessarily elapsed before the cold penetrated to it. It was therefore natural that the time of freezing should occur long after the beginning of the intense cold, which last year started in February. However, though the crack was first observed May 1, 1916, it probably occurred much earlier, as considerable time must have elapsed before the heat penetrated to the frozen pocket of water; but it could be seen only after the liquid began to ooze out, discoloring the surface.

A Parallel Case of Water in a Honeycomb

The writer's original opinion was further strengthened by an account of a parallel case given by one of the engineers of the Nickel Plate R.R., covering the construction of a mass concrete arch in grade-crossing work. In this case, after the structure was built, the water found an opening and escaped in considerable quantities—to such an extent, in fact, that it was thought to have come from some external source. In this instance also, upon cutting into the concrete, a large pocket of honeycombed concrete was discovered, showing that it is quite possible for pockets of water of considerable size to be formed during the pouring of concrete and for the water to remain imprisoned for some time before evaporating.

Referring to the sketches of the arch, it would not be difficult to conceive that, if a wedge were driven into the arch at the intersection of the horizontal and radial cracks, there would be produced a crack very like the one that actually occurred.

While the center of the honeycombed pocket is not directly at the intersection of the cracks, but situated a little farther toward the crown, the radial crack could not be expected to occur at the center of this pocket, because the steel at the extrados extending beyond the center of the pocket prevented the crack from occurring at this point; and it therefore took place just at the end of the steel.

Summary

Since the crack could not have been a tension crack (there being no tension at that point) nor a shear crack (because the shearing stress was very low), since the crack occurred at the end of protracted cold weather and since upon the arrival of warmer weather a considerable amount of liquid emerged from the crack, the writer was obliged to conclude that the pocket must have been full of water, that the water froze and that this freezing split the arch rib. Also, his opinion was strengthened by a similar occurrence called to his attention by another engineer, and in his mind there is little doubt of its being the true conclusion.

Chicago Garbage-Reduction Costs

The garbage-reduction plant now operated by the City of Chicago was taken over from a private company in 1914 and has been altered and improved considerably under the direction of Henry A. Allen, consulting engineer to the city, and head of the Waste-Disposal Bureau in the Department of Public Works. In a paper read by Mr. Allen before the Chicago section of the American Society of Mechanical Enginers, it was shown that the cost of treatment has been reduced materially and a net revenue (really an "operating profit") is expected from operation during 1917.

As to the cost of the plant, the city purchased it from the Chicago Reduction Co. for $275,000. This purchase was largely on account of its value as a "temporary utility," there being no time to secure a site and erect a new plant before the approaching hot weather. At the same time, it put a stop to litigation and controversy.

For the five years, 1909-13, prior to the acquisition of the plant by the city, the city paid the company $47,500 per year, the cost per ton averaging 42c. and ranging from 52.8c. in 1909 to 32.9c. in 1913, owing to the steady increase in quantity of garbage (from 89,957 tons to 144,343 tons). For the first two years of municipal operation (1914 and 1915) the operating cost (no capital charges included) was 76.8c. and 63.2c., this increase in cost being due to the reconstruction of the plant. For 1916, the corresponding cost was only 16.1c., and for 1917 an operating profit of 86.9c. per ton is expected, but again no allowance for capital charges is made. The figures of quantity and cost are given in the accompanying table. The cost of operation includes repairs.

It is estimated that about 150,000 tons of garbage will be delivered in 1917 and will produce 4000 tons of grease and 30,000 tons of tankage. The city has contracts for the sale of the grease at 7.29c. per lb. and the tankage at $4.16 per ton. Mr. Allen states that the former price is high, while the latter is low, the present market value of garbage tankage exceeding $7 per ton.

OPERATING COSTS OF GARBAGE REDUCTION AT CHICAGO

(Capital Charges Not Included)

	1914	1915	1916	1917 (Est.)
Operating cost	$154,684	$278,570	$432,721	$477,000
Revenue	96,585	183,197	410,512	603,000
Net operation	58,099	95,372	22,209	....
Net revenue	....	....	....	126,000
Garbage, tons	75,600	150,875	137,920	145,000
Net cost per ton	$0.768	$0.632	$0.161	
Net profit per ton	....	....	....	$0.869

NOTE.—In the estimate for 1917, the price of grease has been taken at 5c. per lb. and tankage at $5 per ton, both figures much below the present market prices. During 1916 the extractor plant was in operation only from June 1, and the millhouse was not in full operation until the latter part of June. From Jan. 1, to time of starting the extractor plant, the city received only $3.27 a ton for commercially dried garbage, which is green garbage dried down to 10% moisture. The capacity of the old millhouse was not sufficient to handle all garbage degreased, necessitating the storage of approximately 14,000 tons on the property north of the plant, thereby greatly increasing the cost of production of tankage.

Transporting 3000 Tons of Machinery 240 Mi.—Transporting the heavy machinery for the new smelting works of the Atbasar mines of the Spassky Copper Co. in Siberia necessitated laying sections of track from the Trans-Siberian Ry. depot to the smelting works. This distance is 240 mi. and the method employed was to lay about 10 mi. of 35-lb. rail. The equipment was moved this distance, when the track was picked up and laid ahead. The main difficulties were those connected with the climate and the war, says the "Engineering and Mining Journal." Work is possible only 6 mo. of a year and labor (Khirgese tribesmen) is not dependable. The train method was adopted for moving the machinery because the soft roads will not support very heavy trucks—3 tons being the limiting load on a wagon for successful haulage.

Notes from Field and Office

New type of universal calculating machine—Wide concrete pavement with top reinforcement—Accurate construction drawings—Effect on concrete of water and time of mixing

Survey Computations with a Monroe Calculating Machine

The distinctive feature of the Monroe calculating machine is a combination of a standard flexible adding-machine keyboard with a reversible arithmometer and a sliding carriage. It performs addition, subtraction, multiplication and division, or a combination of these operations. It is this combination of adding and computing machine that makes the device particularly useful in engineering offices, where most computations involve all operations simultaneously.

For adding, the successive numbers are set on the keyboard by pressing down the proper keys, and successive forward turns are given the crank (see Fig. 1), the sum appearing in the lower of the two rows of dials on the sliding carriage. For subtraction the larger number is set on the keyboard, and one forward turn registers it on the lower row of dials; to subtract any number from this the number is first set on the keyboard, and then one backward turn of the crank gives the result in the lower row of dials, as before.

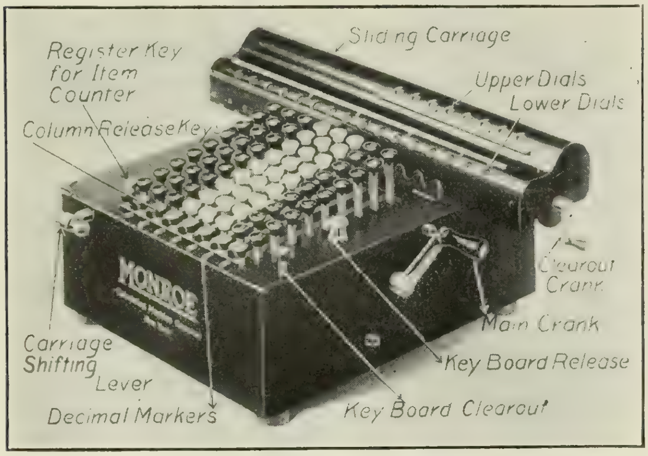


FIG. 1. MONROE COMPUTING MACHINE, SHOWING METHODS OF MANIPULATION

In multiplication the multiplicand is set on the keyboard, and the multiplication is performed by forward turns of the crank, the number of turns being the sum of the digits of the multiplier. For instance, to multiply by 122 the crank is turned once, a shift of the carriage made and then two turns, another shift and two more turns, making five turns in all. The result appears in the lower row of dials and the multiplier in the upper row. To perform division the dividend is registered on the lower dial and the divisor on the keyboard; then the previous process is reversed, as in subtraction, the quotient appearing in the upper row of dials. Square and cube roots may also be computed on the machine.

The application to extended computations is best illustrated by reference to Fig. 2, which represents the plat of a survey of nine lots. Starting at x, the course xl = 144.34 ft. is set on the keyboard by depressing the

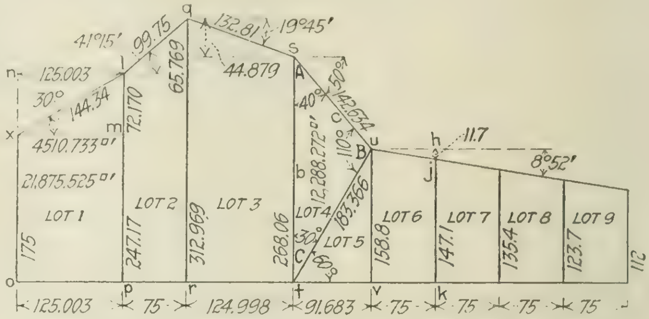


FIG. 2. SURVEY PLAT TO ILLUSTRATE USE OF COMPUTING MACHINE

proper keys. Then by five forward turns of the crank we have multiplied 144.34 by the sine (0.5) of the given angle (30°); the result (72.170), appearing on the lower dials, is the value of the coördinate lm. The sine, appearing on the upper dials, serves as a check.

Now clear the dials by forward and backward turns of the clear-out crank (see Fig. 1) and, the setting of the keyboard remaining unchanged, multiply by the cosine (0.86603) of the angle (30°), 12 forward turns, to obtain the value (125.003) of the coördinate ln.

Obtain the area of the triangle xlm by the formula area $= \frac{bc}{2}$, which gives $\frac{125.003 \times 72.17}{2} = \frac{9021.46651}{2} =$ 4510.733 sq.ft. which is done by 15 turns of the crank. The area of the rectangular section of Lot 1 may be computed and added to the area of the triangular section by leaving 4510.733 on the lower dials and multiplying 125.003 by 175, the number 125.003 having been left on the keyboard after the previous step. The lower dials will then show the sum of the areas computed in the last two steps, which is 26,386.258 sq.ft., the total area of Lot 1. The areas of Lots 2 and 3 may be obtained by the same process as is used for Lot 1.

With xo given, we have $175 + 72.17 = 247.17 = lp$; $lp + 65.769 = 312.939 = qr$; $qr - 44.879 = 268.06 = st$; these are the lengths of the next three vertical lines obtained by three forward and one backward turn of the crank.

Lot 4 presents the solution of an oblique-angled triangle with the three sides given:

$$\text{Cos } A = \frac{c^2 + b^2 - a^2}{2bc} = \frac{142.634^2 + 268.06^2 - 183.366^2}{2 \times 268.06 \times 142.634}$$

$$\frac{20{,}344.458 + 71{,}856.164 - 33{,}623.090}{76{,}468.94} = \frac{58{,}577.532}{76{,}468.94}$$

$$= 0.76603 = \cos 40°$$

$$Sin\ C = \frac{c\ sin\ A}{a} = \frac{142.634 \times 0.64279}{183.366} = \frac{91.6837}{183.366}$$

$$= 0.500 = sin\ 30^\circ$$

$$B = 180^\circ - (A + C) = 110^\circ$$

$$Area = \frac{a \times b \times sin\ C}{2} = \frac{183.366 \times 268.06 \times 0.5}{2}$$

$$= \frac{24{,}576.545}{2} = 12{,}288.272\ sq.ft.$$

In Lot 5 we have:

$$ur = hypotenuse \times sin\ 60^\circ = 183.366 \times 0.86603 = 158.8$$

$$ty = hypotenuse \times cos\ 60^\circ = 183.366 \times 0.5 = 91.683$$

Both multiplications are made with one setting of the keyboard.

The coördinate $jh = 75 \times \tan 8^\circ\ 52' = 75 \times 0.156 = 11.7$, making the boundary $jk = 158.8 - 11.7 = 147.1$; and as each succeeding boundary is 11.7 less than the one preceding it, this subtraction leaves the keyboard and dials set so that each successive backward turn of the crank will cause the lower dials to show the length of the succeeding line.

Angles may be added by using the first two rows of keys for the minutes and the fourth, fifth and sixth for degrees, the third row serving to separate the groups and provide an extra place when the number of minutes totals 100 or more.

The numbers are set and added; the result appears in the lower dials as a continuous line of figures; but as degrees and minutes are sexagesimal quantities, the minutes must be reduced to degrees and added to the degrees column. This may be accomplished by dividing the total number of minutes by 60, the number of degrees and minutes being represented by the quotient and remainder respectively. Both these operations may be performed simultaneously by depressing the 9 in the third row of keys and the 4 in the second row of keys and adding this complement until 0 appears in the hundreds' place and less than 6 in the tens' place, when the result dials will show the correct number of degrees and minutes of the total. By this method it is necessary to watch the minutes' group and make the reduction as often as necessary to prevent the total number of minutes occupying more than three places. This reduction can be made as often as desired without disturbing the degrees' group.

The Monroe calculating-adding machine is manufactured by the Monroe Calculating Machine Co. at its plant in Orange, N. J. The price of the machine is $250. The general offices of the company are in the Woolworth Building, New York City.

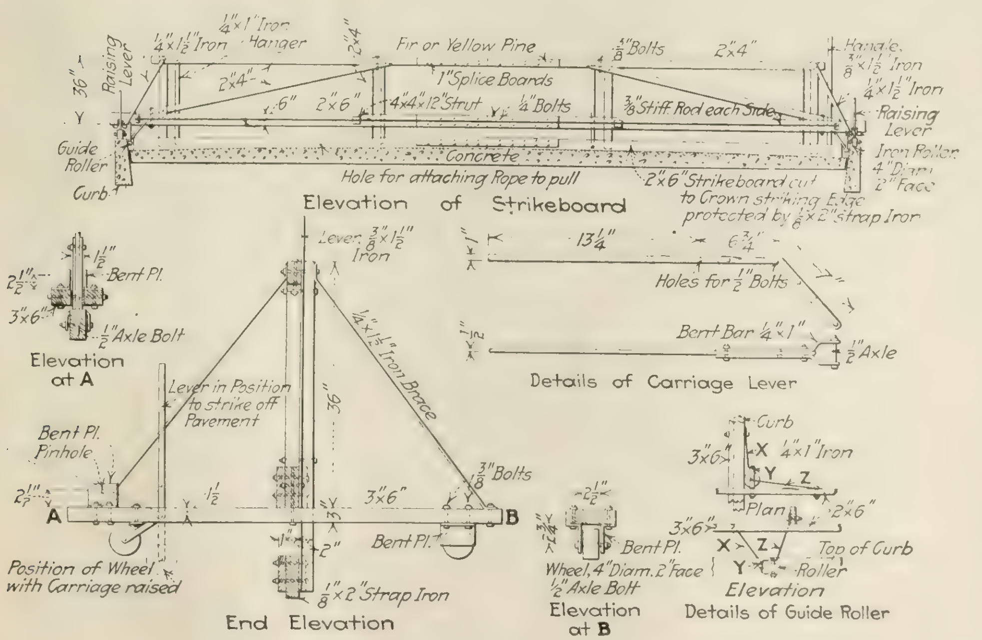
Constructing Wide Concrete Pavements with Top Reinforcement

By Charles A. Alderman*

Concrete paving of unusual width was constructed in Depew, N. Y., a suburb of Buffalo, during the past year. Six streets were paved, aggregating 28,000 sq.yd. Four of these streets were paved 40 ft. wide, and only parts of two of the streets had car tracks, so that most of the pavement was laid in one continuous slab for the full width from curb to curb. Transverse expansion joints 1/4 in. wide, at intervals of 36 ft., and longitudinal joints of the same width along either curb were made of "Genasco," an asphaltic composition.

The pavement is 8 in. thick in the center and 6 in. at the sides. Its surface is shaped to a hyperbolic curve for the middle half-width of the street and to a straight line thence to the gutters, which are 6 in. below the center line. This hyperbolic cross-section is one that was adopted by the New York State Highway Department in 1916 for pavements 20 ft. or more in width.

Reinforcement was placed 2 in. beneath the finished surface. The cross-sectional area of the reinforcing metal running parallel to the center line of the pavement is 0.038 sq.in. per ft., and the cross-sectional area perpendicular to the center line is 0.049 sq.in. per ft. The reinforcing metal extends to within 2 in. of all joints, but does not cross them. Adjacent widths of fabric are lapped 4 in. when perpendicular to the center line of pavement and 1 ft. when parallel to the center line. Reinforcement of the same cross-section as above was placed 2 in. from the bottom of the slab over all new trench backfills, extending 2 ft. on each side. The screed used in finishing the pavement was substantially the same as that designed by the Universal Portland Cement Co. (see accompanying illustration). This screed was made of seasoned lumber, in order to have it as light as possible. It was pulled forward by four men. Too much care and attention cannot be given to detail in the design and construction of a screed, for upon its



DETAILS OF SCREED FOR FINISHING WIDE CONCRETE PAVEMENTS

*Civil Engineer, 575 Ellicott Square, Buffalo, N. Y.

operation the ultimate success of the paving depends. The screed should be made very rigid, so that it will not leave any depressions or humps in the surface.

When the longitudinal street grades were steep, no particular trouble was encountered in getting a satisfactory surface, but where the minimum grade of 0.1% was used, it was found very difficult to get an even, uniform surface, particularly at the gutters. The writer would recommend that in the construction of pavements as wide as 40 ft. the screed be made extra heavy in order that it hug the paving surface more closely.

Brooming of the concrete surface was carried on by means of a heavy broom that was drawn back and forth across the concrete surface by two ropes. Wherever stones appeared on the surface as a result of the brooming they were removed from a finishing bridge spanning the roadway.

The concrete was mixed 1 : 1½ : 3. The fine aggregate consisted of natural sand or screenings that, when dry, would pass a sieve having four meshes per linear inch; not more than 25% was allowed to pass a sieve having 50 meshes per linear inch, and not more than 5% a sieve having 100 meshes per linear inch. The fine aggregate contained less than 3% loam or vegetable matter. The coarse aggregate was such as to pass a 1½-in. round opening and ranged in size from 1½ in. down, not more than 5% passing a screen having four meshes per linear inch.

No cracks have appeared in the pavement to date. The work was begun in May and completed in October by the Harrison Engineering and Construction Corporation, of Buffalo, N. Y. George C. Diehl, Consulting Engineer, of Buffalo, was village engineer, the writer having charge of the work for Mr. Diehl.

Final Building Plans Should Show Actual Construction

By Albert M. Wolf*

Not only is it important to have well-made and complete plans as a guide in the construction of concrete buildings, but it is equally desirable from the standpoint of the owner and his future architect or engineer to have an exact record, available at any time, of the actual construction. Some may think that the minor changes made in certain portions of a building during construction are inconsequential, but after one or two experiences in making extensions or repairs to a building—the final drawings of which are not true records of the actual construction—they will perceive many reasons for this precaution. To depend on the memory of the superintendent for information on changes in construction is as poor business policy as trying to keep large accounts on loose scraps of paper.

Changes in details of foundation and substructure work during the process of construction are more common than in other parts of a building, owing to inability to obtain an exact survey of the foundation soil beforehand. The same is true of service tunnels, trenches and the various underground pipe lines required in a building. If the exact location of these utilities and the character of the changes made are correctly recorded on the final plans, new underground work, machinery foundations and building extensions can be readily laid out in the drafting room without resort to costly surveys or the use of erroneous plans.

Equally important is the recording of changes in construction of the framework of a building or the inclosing walls, interior partitions, etc.—for when an owner desires changes or additions to the layout of his building, the architect or engineer should be able to make up the necessary plans or the desired reports without going to the expense of making careful surveys of existing conditions. Nothing is more exasperating than to design the foundations of an extension to an old building, or of a new one adjacent to an existing structure, and to find on excavating for the new work that the old foundations were carried down much farther than the plans indicated. The result is rush work on revisions, and heavy bills of extras to the owner, which are unjustifiable from the standpoint of the designer of the existing building. The architect or engineer in charge of the later work has a right to assume that his predecessor served his client's interests scrupulously. If this were not the case, plans would be of little value for future reference.

It is the writer's practice to furnish the superintendent on the job with a set of blueprints of the detail construction drawings. Upon these prints he is instructed to indicate in ink all field revisions and additions. When the job is completed, this set of plans is turned in to the home office, where the changes are made on the record tracings. Care is taken to note these with dates in the space allotted for this purpose. Then the tracing is marked: "Final Revision To Show Actual Construction." A set of prints is furnished the owner for his reference, and another set is filed with the contract set of plans, while copies of the construction prints and the superintendent's record set are issued. That this little extra expenditure on drawings pays, goes without saying.

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Deep Open Trenching for a 72-In. Reinforced-Concrete Pipe

(Contributed)

In connection with the construction of a 72-in. water-supply intake main for the Solvay Process Co., Syracuse, N. Y., some very difficult open-trench work was necessary. The intake main extends 1250 ft. out into Lake Onondaga from a reinforced-concrete well on shore.

From the intake well for a distance of 1350 ft. a 72-in. reinforced-concrete pipe was constructed in place. Landward of the well the pipe passes through a tunnel to the large sump in the new pumphouse of the Solvay Process Co. Much difficulty was encountered in digging the trench and keeping it open, on account of its great depth, 38.5 ft.

On each side of the trench was driven 45-ft. Lackawanna steel sheetpiling, strutted with braces 8 ft. apart between longitudinal waling placed every 6 ft. vertically. Even with this quantity of bracing it was common to see a brace indented into the waling timbers at least 1 in., and a great many of the braces buckled and broke, owing to the enormous pressure. This trench passed through what is known as the "waste bed." The material, which consists of waste lime products from the Solvay plant, is of a plastic nature that causes it to exert

a greater pressure than any other material that the writer has ever seen. This was especially the case after a heavy rain.

Beneath this material and about 7 ft. above grade, there was from 3 to 4 ft. of black muck overlying several feet of marl, quicksand and silt. As soon as the marl was dug away and the sand encountered, it would start flowing into the trench from the surrounding territory, the heavy weight of the waste bed on top forcing it down, carrying the steel sheeting with it. Great difficulty was experienced in keeping the sheeting near a level where it would serve its purpose. The settlement of the sheeting would of course disarrange the braces so that it was necessary practically to double the bracing.

When grade was obtained in the open trench, piles varying from 25 to 45 ft. were driven in the bottom, on which were placed 12x12-in. caps and a 4-in. yellow-pine floor. As an indication of the character of the bottom it may be said that some of the 45-ft. piles were driven to grade with practically the weight of the hammer.

After the piles were in place, caps and grillage on, it was necessary to brace from the longitudinals down to the top of the floor to keep it from rising up, and in several instances it did rise at least a foot, making it necessary to drive the flooring down again and brace it. So in addition to the large amount of bracing required for the sidewalls, it was necessary to brace the floor throughout in order to hold it in its position after it was completed and ready for the forms.

The forms and reinforcement were placed and the concrete deposited, making a 72-in. reinforced-concrete pipe with 15-in. walls. The reinforcement used was 3-in. triangular mesh, American Steel and Wire Co. type, made up in 5-ft. sections, and each section was laid overlapping the next by 3 in. As the concrete pipe was completed, the trench behind was filled in with cinders and other material, after which the sheeting was pulled and redriven to form another section of trench.

The many and extraordinary difficulties met with on this job and the great depth of open trench made the progress much slower than anticipated. The concrete used in the pipe line was a 1 : 2 : 4 mix with limestone from the Jamesville quarry. The work was done by the Great Lakes Dredge and Dock Co., of Buffalo, N. Y., for which company the writer is division engineer.

VIEW OF SYRACUSE TRENCH, SHOWING SECTION OF 72-IN. PIPE

Effect of Water and of Time of Mixing on Concrete Strength

The testing laboratory of the Public Service Commission, State of New York, has conducted field and office experiments on concrete ever since the starting of the new New York City subways some five years ago. As a result it has accumulated many data on the behavior of concrete, some of which were outlined by J. G. Steinle, Assistant Engineer of the commission, at the recent convention of the American Concrete Institute. In regard to two very timely factors, the amount of water and the duration of mixing, Mr. Steinle had the following to say:

Effect of Consistency on Concrete

The result of testing a large number of concrete cylinders made in the field seems to indicate that, next to the cement, the most important factors affecting the strength of the concrete are the field conditions under which it is made. Of these factors the consistency of the mix perhaps causes the greatest variations in the strength, especially on specimens tested up to 28 days. In spite of the fact that the test cylinders show that concrete of wet consistency possesses a low compressive strength, it is at times necessary on subway work to use wet mixtures on account of the difficulty of passing it through chutes and because of complicated forms and reinforcements. The effect of an excess of water is to swell the volume and reduce the density. In an excessively wet mixture there will be more or less separation of materials, and concrete of uniform quality will not ordinarily be produced. An excess of water will also interfere with the chemical reaction of the cement and cause the concrete to become both slow setting and slow hardening. Field tests show that a concrete of a quaking consistency will give the best results. It will also be observed that, whereas a concrete of very wet consistency when sampled and tested in the usual way will show low results, the *same concrete* when cut from the structure will not show the same relative weakness. This may be partly explained by the fact that a large part of the water and lighter particles, in actual practice, rise to the top of the form and are not confined in the mass of concrete. The effect of the time of mixing of concrete on its compressive strength cannot be well established from data obtained from field tests, as most of the specimens are taken from the forms and not directly from the mixer. The total mixing of the concrete is made up in part by that received in the mixer and in part by passing through chutes, rehandling, etc. The actual effect of the treatment in the mixer on the strength of the specimen made in this way is partly lost. The fol-

lowing tests, made on concrete mixed for 1 min., 30 sec. and 10 sec. and then passed through long chutes will illustrate this point:

Test No.	Time Mixed, Sec.	Age, Days	Consistency	Ultimate Strength, Lb. per Sq.In.
1	10	7	Wet	1,268
2	30	7	Wet	996
3	60	7	Wet	1,144

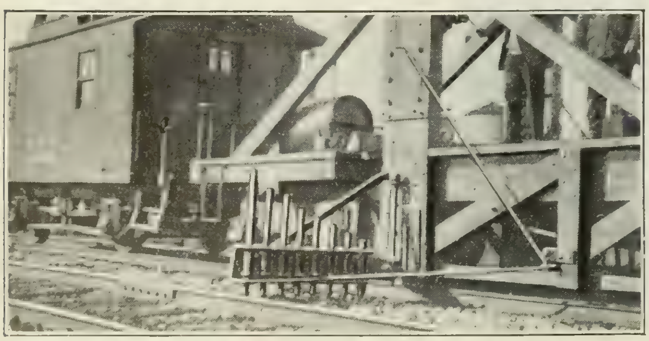
The best and most uniform test results have been obtained on concrete mixed for at least one minute after all the ingredients had been added. Thorough mixing will remove films of air adhering to particles and will reduce the amount of air confined in the mix; it will also increase the fluidity of the mix and thereby reduce the amount of water required. Test specimens, which show low compressive strength, usually fail because of the breaking of the bond between the mortar and the coarse aggregate. The certainty of securing a bond between the broken stone or gravel and the mortar is greatly increased by continued mechanical mixing, as a film of silt or a coating of stone dust enveloping the larger particles is removed and a cleaned surface is exposed to the mortar. This could not be easily accomplished by hand mixing and may account for the prejudice against the use of gravel before the introduction of machine mixing.

The speed at which a mixer is run does not necessarily govern the time required to secure a proper mix, as it has been observed that when a mixer runs fast the concrete has a tendency to cling to its sides and does not travel properly through all machines. A uniform gray color of the mix does not necessarily establish the fact that it has received sufficient mixing.

FINE AGGREGATE

Rapid Progress in Tunnel Lining by the pneumatic process is being made in the Wilson Ave. tunnel for the Chicago water-supply system. During January one outfit mixed and placed concrete in three 30-ft. lengths of forms daily, and on two consecutive days four forms were completed. These 30-ft. forms contain an average of 2 yd. of concrete per lineal foot. The men have been working two 8-hr. shifts. Four concreting outfits are in use, but the work mentioned represents that of one outfit. The pneumatic equipment was furnished by the Concrete Mixing and Placing Co., of Chicago. The tunnel is about 8 mi. long and is 12 ft. in diameter. It is being built by day labor under the direction of John Ericson, City Engineer, and Henry W. Clausen, Engineer of Water-Works Construction, as described in "Engineering News," May 25, 1916.

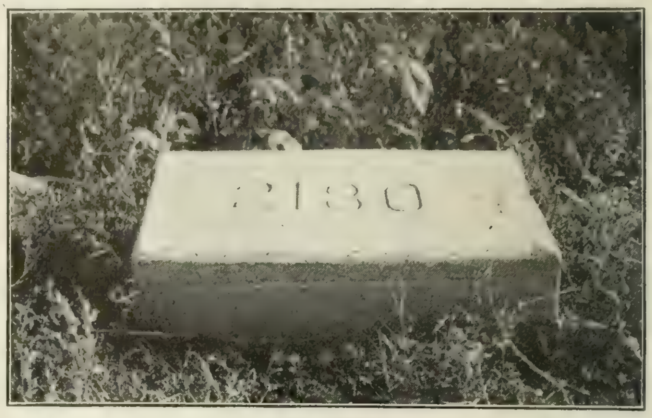
Ballast-Cleaning Device—On the New York Central R.R. there is considerable trouble caused by grain dropping from cars and growing in the stone ballast. An excessive amount of work by the trackmen is required to keep down the growth, and the device shown herewith has been invented to eliminate this handwork. It consists of arms or wings, attached to the



BALLAST-CLEANING DEVICE; NEW YORK CENTRAL R.R.

posts of a spreader car, each carrying a row of vertical rods or teeth. These rods are graduated in length to conform to the contour of the outside shoulder of the ballast, and a small blade on the extreme end of the outside wing keeps the ballast in its original shape. The car is run at a speed of about 6 mi. per hr., and one trip is sufficient to clean and trim the ballast. It not only cleans out all vegetation, but causes the fine stuff and dirt to settle to the bottom of the ballast so that weeds and grain are less likely to grow. This device is the invention of A. M. Clough, Supervisor of Track, New York Central Lines, Batavia, N. Y.

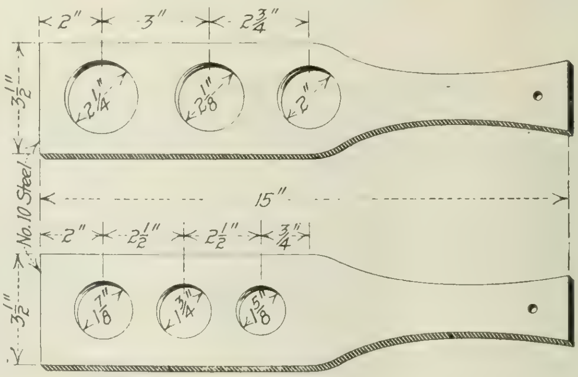
A Method of Numbering Highway Bridges and culverts to provide standardization throughout the different counties in designating the various structures and to afford an accurate basis for complete and authentic office records has been adopted by the Ohio State Highway Commission. According to Le Roy W. Allison, this plan, now in effect in Hardin County, consists in stenciling the numbers in the concrete



HOW STATE HIGHWAY BRIDGES AND CULVERTS ARE NUMBERED IN OHIO

before the latter has set, each road foreman being supplied with uniform numeral stencils. The number is pressed in a conspicuous place and is clearly legible, as indicated in the illustration. This plan makes it easy for roadworking crews and foremen to locate a particular structure. It is also convenient for people using the highways.

A Hand Gage for Drill Bits is used in the steel-sharpening shop of the Wisconsin Zinc Co. mines near Platteville, Wis. J. E. O'Rourke—whose drill-sharpening article won first prize



HAND GAGE FOR ROCK-DRILL BITS

in the recent "Engineering News" prize contest—states that this gage can be used to good advantage by a novice on the sharpener in checking his steels, until he becomes familiar with the machine.

Exhaust Steam to Heat Concrete Water—Where steam-driven concrete-mixing plants are used a supply of hot water for mixing purposes can be had without extra expense for fuel by utilizing the exhaust steam for heating the water, passing this exhaust through a coil hot-water heater in a manner similar to boiler-plant practice. Around the coils is passed the water on its way to the mixer. The exhaust, for each horsepower of engine, should heat up to 180° F. or higher about 180 lb. of water. In the heater coils about ⅓ sq.ft. of heating surface should be provided for every 30 lb. per min. of water to be heated.—W. A. Tayler, 3634 North 12th St., Philadelphia.

Editorials

For close to half a century, the civil engineering profession in the United States has been served by two journals, *Engineering News* and the *Engineering Record,* occupying practically the same field. The publishers announce on the front cover of this issue the completion of arrangements for the consolidation of these two journals as the *Engineering News-Record,* the first issue of which will appear on April 5. This consolidation is made possible as one result of the amalgamation of the two publishing companies, the Hill Publishing Co. and the McGraw Publishing Co., which are to be reorganized as the McGraw-Hill Publishing Co., and will continue the publication of the consolidated journal and the other nine technical journals heretofore issued by the separate companies.

The *Engineering News-Record* will have the advantage of an enlarged editorial staff and the combined experience and ability of the organizations which have hitherto produced the two separate journals. A larger and better journal and a higher quality of service to the engineering profession of the United States are the results which may be confidently expected to grow out of this consolidation.

Subscribers to either of the two journals will receive the consolidated journal after April 5 and those subscribing to both journals will have their subscriptions extended for a period equal to the sum of the times for which advance payment has been made.

Milestones in Engineering Practice

A timely commentary on the need for engineering journals and engineering societies is made by noting how few engineers around the country (in peace times we would have said around the world) are aware of the recent completion of what is, for the moment, the greatest drainage reclamation project and the greatest drainage pumping station—the Mattamuskeet district and the New Holland station. The notes that appear elsewhere in this issue on the district and the station well typify that endless series of technical reports from the editors to the readers, each made during a personal inspection and a careful study of the problems and their solutions—in an endeavor to carry our thousands of readers to those out-of-the-way spots, and to render accessible to the many the transferable elements in the experience of the few.

The handful of men in the country who have become familiar with the Mattamuskeet work speak of it as the "greatest" project and the "greatest" station. The justification of these adjectives here, as in dozens of previous cases, becomes a matter of definition. It is not difficult to fix a place for this piece of work in the drainage reclamation projects of this country or Europe. In acreage served by a single system of canals, and in area of virgin reclaimed land, Mattamuskeet appears to be the largest piece of American work, its 100,000 (total) and 50,000 (reclaimed) acres towering above the 27,000-acre Neches Canal district in Texas, or the 66,000-acre Sutter Basin district in California. But, of course, the Mattamuskeet project is not as large as some of the advertised chains of smaller single projects—for example, the 100,000-acre holdings of the Louisiana Meadows Co.

Louisiana has only 250,000 acres of reclaimed land. Practically all the bottomlands along the Illinois River have been recovered and they constitute a total of 182,000 acres. On the Mississippi River between Muscatine and St. Louis there are some 340,000 acres reclaimed. The Great Haarlem Lake in Holland has only 42,000 acres. The southern Zuyder Zee project will reclaim 500,000 acres, and it will have 15 steam plants of 17,000 hp. combined. The entire fens of Eastern England have only about 360,000 acres in all—only about 125,000 acres being drained by steam pumps in 13 districts having 800 to 35,000 acres each.

The New Holland station with its four 850-hp. 560-sec.ft. 10½-ft. steam units itself must be compared with that of the Sutter Basin electric plant with its six 800-hp. 175-sec.ft. 29-ft. units, the latter station being greater in horsepower capacity, but much smaller in volume of delivery.

After all, such questions of size are only of passing moment compared with the engineering work as it may prominently illustrate the trend of engineering development and constitute a milestone to which we may carry forward comparisons out of past history or look back to in future years. The Mattamuskeet plant is a milestone in that it exemplifies most interestingly the business side of engineering; there was not merely a task to be done, but one to be done with perpetually the least overall annual expenditure and with the greatest insurance of continuity of service. How both aims were embodied suggests itself from an examination of the plans on another page—in the substantial foundations and substructure, fireproof long-lived superstructure, high-class machinery, modern forms of intake and discharges, and in adequate hydraulic and power capacity. These features are in great contrast, each and all, with most of the early drainage plants in America. The evidences of that higher economy which marks the commercial imprint on engineering design is seen even in the details. For instance, in the pumps, of unparalleled output for centrifugal units, the development expense is kept low by employing four parallel stages each of a size well within the limits of extensive experience and involving no untried elements, no huge new patterns or castings. The stages are combined so that, without expensive valves

or complications, each unit can give service with one, two, or three quarters of the pump and half the engine, should contingency arise.

Truly such plants deserve to be recorded as milestones of our progress; and the editors are justified occasionally in reminding the readers that the searching out of such cases is one of the most important tasks to which the coöperation of all is invited.

A Tragedy of Errors

Once more a structure in which the safety factor has proved to be less than unity serves as an impressive exhibit of how not to build. There were so many things wrong with the construction of the Post St. bridge at Spokane, which collapsed on Feb. 7, as described in detail in *Engineering News* last week, that noting them would seem superfluous had not the accident occurred in a progressive city under engineering auspices which seemed beforehand to be of the best, and far above the need of elementary instruction in structural methods. That such an accident can happen only goes to show how persistent must be the reiteration of fundamentals.

The faulty construction of the centering which failed to support the 250-ft. concrete arch is the most obvious and spectacular feature of the catastrophe. This structure was about as far from safe as it could well be and stand up at all. Passing over the evident lightness of the designed framing as a dangerous but not necessarily fatal defect, one may note three details in which the construction of the centers falls short of safety—the insecure footing of the piles, the substitution of spikes and toenails for the usual bolted or framed joints in the timbering and the use of two 4 x 8's spiked together for the required 8 x 8-in. posts. Of these, probably the first was the primary cause of collapse but the second made sure a complete failure once high water, drift or current had undermined one or more of the pile footings, or once the structure was subjected to any twisting strain. An inspection of the close-up view and the sketch details of the falsework, shown in these columns last week, is informing. How any competent constructor could permit such cobhouse blocking, insecurely held supports and profuse shimming is past comprehension, particularly when it is remembered that only a few years ago the Post St. bridge would have been the longest span concrete arch on record. For an arch of one-tenth the span good practice would have condemned falsework so constructed.

But, engineers will ask, how does it happen that such laxness was possible in a large municipal structure? There are some pertinent facts which such questioners should know. In the first place, the contract was let to the lowest bidder on proof of his financial stability and with no regard for his experience in this class of work. This experience being negligible, the contractor employed as his superintendent an engineer then in the city's employ, who had been connected with other similar bridges across the same river. Apparently the entire responsibility for the work was placed upon this engineer. Local reports have it that this man, who was in desperate financial straits, was paid a nominal salary but was to be allowed a disproportionate part of the firm's possible profits on the job. On him all of the responsibility for the design and construction of the falsework has been placed, in such investigations as have been made public. His side of the case will never be known, for he was killed by a fall from the bridge only a week before its collapse.

So much for the contractor. At the coroner's inquest the City Engineer stated that he had never seen the plans of the falsework until two or three days after the accident and that he did not consider it the duty of the city to concern itself with the details of the arch centering. To quote a newspaper account of the testimony, "Contractors are supposed to look after the safety of their own men." Had the city been building the bridge by day labor, he said, the City Engineer's office would have checked every detail of the work; but a contract having been let, only a general supervision was incumbent upon the city's representative. Incidentally, his office seems to have been overburdened with work.

Thus in the train of circumstances we have an enforced letting to the lowest bidder, common enough but often dangerous, and a contractor's superintendent driven to economies by the spur of needed profits but not checked by a supervisory engineer looking single-eyed to safety. The combination was fatal—as it would prove to be five times out of ten.

Some consolation might be had in the fact that such a tragedy of errors could never happen if any one of the elements in the train had been up to best or even standard practice were it not for the fact that it is the lapses from good practice that bring disaster. For that reason, if for no other reason, the story of the Post St. bridge should be read and inwardly digested by every engineer.

Big Experiment in Community Planning

An extensive practical attempt is being made in North Carolina to build up on sound engineering and sociological lines an agricultural district in which may be developed all the joys of best community life combined with the independence of the farmer. This is the first attempt of this sort in America—at least on any such scale and with any such completeness of plans. The opportunity, however, was unusual, for here at New Holland, as described elsewhere in this issue, a single engineering project opened up an untouched fertile area of 50,000 acres under the control of a single group of promoters, but surrounded by a ring of prosperous farms.

If the plans of the Mattamuskeet lake-bed owners go through in their entirety, then there will be a network of drainage and light transportation canals and a parallel system of roads, well planned, properly constructed and adequately maintained. There would be built one large town and three subsidiary community centers, each with post office, stores, schools and other social facilities. There would be some definite provision for binding the residents of this district together with various common political and social interests that should promote acquaintance and coöperation. Manifestly, if these ambitious plans can be carried to completion, the experiment will be of great value to the entire country, as it ought to demonstrate how rural life can be made more prosperous and attractive than metropolitan existence.

But the Mattamuskeet promoters must, for the greatest measure of success, exercise extreme caution in securing proper colonists. They must preserve their ideal of what

this community can be. They must back their convictions with courage—and money. In this last element lies the key to the success of the experiment, for the fixed charges on the entire vast property must be carried along by the pioneers until the land is colonized; and there is some danger that the burden may become so great that the present owners may be led to sell off a big tract without restrictions. A fair profit seems promised the Mattamuskeet men on their risked capital, if they are tenacious—and, what is more satisfying, lasting credit for conspicuous attainment in the improvement of American rural conditions.

City Planning Sweeps On but Needs More Help from Engineers

The gospel of city planning is being preached throughout the length and breadth of the country and city-planning commissions are being created or are already at work as never before. Plans more or less comprehensive are being executed in cities large and small. In all this preaching and planning and realization of plans the engineer is taking a considerable part, but he might do more if he were more awake to the opportunity and better fitted by reading, observation and practice to grasp it.

Glimpses here and there of what has been going on of late will serve to give some idea, but a very incomplete one, of current city-planning activities. These birdseye views are confined chiefly to propaganda, new commissions and the like and take little account of plans being executed.

At Bridgeport, Conn., a so-called final report on city planning, which it is hoped is really only the beginning of actual work, has been made by John Nolen, of Cambridge, Mass. About 70 local corporations, firms and individuals contributed $4370 for the studies, besides which the city appropriated $6000. The sudden rapid growth of Bridgeport of late makes intelligent control of city planning almost imperative, but not every city in need of such work has yet entered upon it.

In Pennsylvania the Altoona Real Estate Exchange was recently addressed by a member of the Reading City-Planning Commission who is also an officer of the Pennsylvania State Association of Planning Commissions. Here we have a combination of real estate interest, coöperation from another city and mention of a state association. At Reading two sets of city-planning improvements were recently on exhibit at the city hall: One by E. B. Ulrich, city engineer, and one by Emil Nuebling, engineer on the City-Planning Commission. Friendly rivalry between engineers may stimulate local interest in city planning and deserves encouragement.

Way down in Alabama, says the Birmingham *Herald*, a model industrial area of 25 acres is being laid out near Acipco (note the combination of letters) for the American Cast-Iron Pipe Co. by "Morris Knowles, the well-known Boston landscape architect"—doubtless referring to the Pittsburgh engineer of that name.

Ohio shows current activity in four leading cities. Taking them alphabetically we note that at Cincinnati, Dr. Werner Hegemman, city-planning expert, delivered his second lecture under the auspices of the Germanist Society. In Cleveland a clearing house for the city-planning committees of seven civic societies has been formed under the name of the Cleveland City-Planning Federation, as a result of a year's efforts by the directors of the Cleveland Engineering Society. At Mansfield, the City-Planning Commission has secured from the City Council tentative approval of a scheme to exclude an objectionable class of buildings from certain localities and is working on a scheme for residence, business and manufacturing districts. At Toledo, a civic center project was to be discussed at the convention of the Ohio State Association of Architects.

City-planning exhibits in South Bend and Indianapolis will doubtless stimulate interest in city planning in those cities and throughout Indiana, as has been the case with similar exhibits in many other places under the direction of the American City Bureau. Already a bill is before the Indiana Legislature which would compel all cities of the first to fourth class and permit fifth-class cities (under 10,000 population) to establish city-planning commissions.

Jumping to California, the City Council of Fresno, on recommendation of its City-Planning Commission, has authorized the employment of Charles H. Cheney, consultant in city planning, to make six surveys and reports on various city-planning matters, completing one at the end of each successive month, the earlier ones to be of a quick preliminary character in order to get certain matters into line as soon as possible. This shows commendable zeal for early progress.

At Los Angeles a few days ago the Bunker Hill civic center project was again publicly urged, this time by R. S. Rankin, landscape engineer, and Dr. T. P. Gerson, in addressses before the City-Planning Commission.

As has been intimated, the foregoing are only scattered instances, geographically and in character, of what is going on all over the country. There are scores, perhaps a hundred or two, of city-planning commissions—from Massachusetts to California. They are compulsory for all cities in Massachusetts and for a certain class of cities in Pennsylvania and permissive in several other states. New commissions are coming into existence everywhere, either by compulsion, or choice.

No one can deny that the city-planning movement as a whole is sound. It has been far too long delayed everywhere; particularly in America. Present day municipal and social conditions demand widespread, intelligent interest in the subject. Engineers can appreciate this better than most men. They should join in the movement with voice and pen, as they have done at Cleveland.

Oratory, printers' ink and wall exhibits will go far toward arousing interest in city planning; but properly conceived and well executed plans must follow if enthusiasm is to be converted into results. For the immediate future the demand for city plans will outrun the capacity of the men competent to supply them but the chances are many and strong that amateurs and pretenders in city planning will be engaged in many cities. Engineers can help avert this danger. They can urge the importance of securing competent city planners and point out the way to secure such. This may require more study of city planning than has yet been given it by more than a very few engineers, but the subject will prove fascinating to many, will be broadening to all who pursue it wisely, and may qualify a few engineers as expert city planners.

Letters to the Editor

The Narrow-Gage Delusion

Sir—In your issue of Jan. 18, referring to the "Narrow-Gage Delusion," you concede that "a narrow-gage line may be justified in rough mountainous country where extremely sharp curvature is necessary to reduce construction cost."

As a matter of fact, however, even this is not true "within the practical limits of railway operation" for roads of gages of 3 ft. or over. We know, to cite the oft-mentioned case, that thousands of passengers are moved daily in New York City on the 4-ft. 8½-in. gage elevated railroads around curves of 90 ft. radius, and I doubt if there is a country in the world which would permit a 3-ft. gage line to be built with curves of as small a radius as this (the minimum radius allowed on the meter gage lines in the Argentine is 490 ft.).

Curves of anything less than 500 ft. radius are objectionable on any railroad; but curves of much less radius can be operated without danger and entirely within the range of practicability on any railroad up to 5-ft. gage using properly designed rolling stock.

The narrow-gage fallacy is truly a delusion from every point of view. F. LAVIS.

120 Broadway, New York, Feb. 15, 1917.

Excessive Rainfall in 25 Minutes

Sir—Prof. Alfred J. Henry's paper entitled "Floods in the East Gulf and South Atlantic States, July, 1916," printed in the August, 1916, "Monthly Weather Review" and abstracted in "Engineering News" of Nov. 9, 1916, is, as you say, "a valuable special study." In view of this fact I am particularly surprised to note that in the opinion of Professor Henry the precipitation of 2.17 in. in 25 min., which occurred at Mobile, Ala., on July 8. 1916, "appears to be the greatest fall for 25 min. in August as far as the records of automatic gages are concerned." ("Monthly Weather Review," August, 1916, p. 468; "Engineering News," Nov. 9, 1916, p. 887.) The use of the word "appears" by Professor Henry reminds me of the old adage, "Appearances are often deceitful."

From my carbon copy of manuscript, now in the printer's hands, I have gleaned the following facts respecting excessive rates of precipitation. On the basis of the reports of excessive precipitation observed by means of automatic gages at the regular United States Weather Bureau stations and reported in the annual reports of the Weather Bureau, the rate of precipitation mentioned by Professor Henry was about equaled or exceeded on an average of once a year, between 1896 and 1914 inclusive. Evidently, this rate of precipitation is not nearly so extraordinary as Professor Henry's comments would lead one to believe. While the rates of precipitation that I give herewith did not all occur in August, this fact, in most cases at least, makes them more exceptional, rather than less so.

EXCESSIVE PRECIPITATION IN 25 MINUTES

(From records of United States Weather Bureau, 1896 to 1914)

Station	Date	Precipitation in 25 Min.
Pensacola, Fla	Oct. 20, 1909	3.37
Taylor, Tex	Apr. 29, 1905	2.83
Anniston, Ala	Sept. 5, 1906	2.68
Thomasville, Ga	June 27, 1909	2.66
Kansas City, Mo	Aug. 23, 1906	2.65
Augusta, Ga	June 18, 1911	2.46
Galveston, Tex	Oct. 22, 1913	2.45
Galveston, Tex	Oct. 6, 1910	2.37
Raleigh, N. C	July 14, 1914	2.35
Jupiter, Fla	Oct. 28, 1908	2.29
Galveston, Tex	Apr. 22, 1904	2.28
Richmond, Va	Aug. 19, 1908	2.27
Lincoln, Neb	July 25, 1914	2.24
New Orleans, La	Sept. 30, 1905	2.23
Baltimore, Md	Aug. 25, 1911	2.22
Concord, N. H	July 7, 1907	2.18
Montgomery, Ala	May 30, 1905	2.15
Meridian, Miss	Aug. 13, 1906	2.15
Cincinnati, Ohio	May 20, 1902	2.13

The table contains three August records out of a total of 16 records that exceed the Mobile record of July 8, 1916, and three records that nearly equal it. A number of additional records that nearly equal the Mobile rate could be given.

The foregoing comments apply to Professor Henry's statements as printed. Why this storm, which is given as having occurred on July 7, on page 427 of the July "Monthly Weather Review," and on both July 7 and July 8, on page 468 of the August "Monthly Weather Review," is referred to as an "August" storm is not apparent. That is one reason why I have included other than August storms in my list. Moreover, according to the data given on page 468 of Professor Henry's article, the precipitation was 1.92 in. in 25 min. instead of 2.17 in. Furthermore, the data given on page 427 of the July issue of the "Monthly Weather Review" for the same storm give 1.62 in. in 25 min. This value, however, might be increased somewhat if the complete 5-min. accumulations for the later part of the storm had been published.

It might be remarked that the portion of the manuscript above referred to, from which these precipitation data are taken, is the result of a six months' intensive study of precipitation data by a member of the writer's office staff and will no doubt contain considerable additional information of interest and value to those engineers who have occasion to use meteorological data. ADOLPH F. MEYER.

Minneapolis, Minn., Jan. 25, 1917.

[Proof of Professor Meyer's letter has been submitted to Professor Henry. The comment of the latter follows.—Editor.]

Sir—When I prepared the original article it was physically impossible, in the short time at my disposal, to make a thorough examination of the previous 25-minute records of excessive precipitation, especially by reason of the fact that the arrangement of the records does not lend itself to a ready determination of the maximum amount for any 25-minute period. In fact, it is only by recourse to the original records that the maximum 25-minute rate for the entire storm can be accurately obtained. For this reason, and also because it was not a matter of vital interest whether or not the Mobile rain storm was the greatest on record, I made the remark quoted by Professor Meyer. In Professor Meyer's list, which includes a record of 13 years, three cases of July precipitation in excess of the Mobile rain storm are given, or about one every four years, which, after all, we should not consider as a frequent phenomenon. I regret that the slip occurred.

Washington, D. C., Feb. 2, 1917. A. J. HENRY.

Humorous Side of Sewage Disposal

Sir—An element of gayety was added to a recent meeting of the New Hampshire Board of Health by a letter from an irate citizen, evidently a French Canadian, who had got the idea that a house sewage-disposal tank recommended by the board would produce good drinking water. The letter, which was originally sent to the health officer of Lisbon, who had given the citizen instructions for building the tank and had said that the effluent would be as clear as ordinary brook water, follows:

I write to tell you dat the box built by Louis LaFlam to make water from Priva as good as new is not worth one dam. He built box just as you say plug up tight with out hole only one end and run pipe to my barn for cow and horse which wond drink water I dont know why, but think it no good so I try it. I dont feel much good two three day my man Joe Bodro try it he puke all over place have Dr. You send me $25 all right if not I give you dam licking some time. (signed) LOUIS LA FLAM.

By way of further explanation it may be noted that in "Engineering News" of Dec. 17, 1908, there was reprinted an article from the New Hampshire "Bulletin of Sanitation," showing how a cesspool has been remodeled so as to provide free discharge that gave no offense. Several hundred tight, free-flowing sewage tanks have been built in New Hampshire for household use and for summer resorts, which have successfully accomplished their purpose in producing an effluent that is as clear as ordinary pond water and practically odorless. The writer has on his table samples of effluent from such tanks, at least one of which is more than two years old and all of which have remained practically clear and have developed no unpleasant odor. Those who build such tanks are advised that this effluent is still sewage and must not be allowed to reach any source of water-supply.

ROBERT FLETCHER,
President New Hampshire Board of Health.

Hanover, N. H., Feb. 13, 1917.

Army Engineer Reserve Corps Filling

Commissions had been accepted by 71 officers in the Engineers Reserve Corps, U. S. Army, up to Feb. 15, 1917; over 1200 applications have been received and are being made at a rate of 150 to 200 per month. Examining boards in important cities are still busy. The pertinent parts of the Army Reorganization Act of June 3, 1916, were abstracted in *Engineering News*, July 13, 1916, p. 93, and the governing orders of the War Department, defining qualifications, were given Aug. 17, p. 327. Application should be made to the Chief of Engineers, War Department, Washington, D. C.

In war operations, the Engineer Corps of the Army is required to furnish officers for duty (1) with the forces at the front, and (2) on lines of communication in rear of the front, or for special services in other localities. The two services are coördinate and of equal importance, but for purposes of classification in the records, the examining boards for the Engineer Reserve are required to recommend candidates for one class or the other. On account of the fact that the first class, designated Class A for convenience, will presumably be needed first for service with the mobile army, candidates for the higher grades (captain or major) are examined in military subjects. As there will be more time for the military training of the second class (designated Class B) no examination in military subjects is required, though military training is considered. In actual service, men in Class B may be used for services usually required of Class A, and in the commissions of officers no distinction is made.

The qualifications of engineers who are wanted for commission in the Engineer Officers' Reserve Corps, together with some of the duties required of them are as follows:

CIVIL ENGINEERS

General construction engineers, for the design, construction and maintenance of earth and concrete fortifications, wharves, piers and buildings of all kinds; highway engineers, for the layout, construction and maintenance of roads and trails on lines of communication or in other localities, including highway bridges of all kinds, ferries, fords, etc.; sanitary engineers, for the design, construction, maintenance and operation of water-works, sewage-disposal plants, etc., in connection with camps or localities occupied by troops within the zone of operations; topographical engineers, for making maps of all kinds within the actual or probable zone of operations, for training of topographical units for the front, and for all kinds of map reproduction, especially photo-lithography.

ELECTRICAL ENGINEERS

This class will be required for services such as the following: Design, construction, maintenance and operation of electric railways forming a part of the lines of communication, including the power plants connected therewith; the installation and operation of electric plants at seacoast fortifications and such power plants as may be needed on the lines of communication; the operation and maintenance of searchlights and other electrical equipment used in the protection of places on the lines of communication or other places not at seacoast fortifications; the training of troops in the care and operation of searchlights for the services of the front; the repair of searchlights and other electrical equipment used by troops at the front.

RAILROAD ENGINEERS AND OPERATING OFFICIALS

This class requires all those engineers and operating officials ordinarily included in the organization of a commercial railroad system, including engineers for the location and construction of track, bridges, stations, etc.; engineers and officials for the maintenance of same, including wrecking operations; operating officials, such as general managers, superintendents, etc.

MECHANICAL ENGINEERS

This class will be required for such services as the installation and operation of machine shops for the maintenance and repair of railroad or other engineer equipment used on the lines of communication and for the design, maintenance and repair of engineer equipment used by the combatant troops at the front, including the field railways.

MINING ENGINEERS

This class will be required for such services as the construction of fortifications on the lines of communication or other places removed from the front; in the training of troops for service at the front in sapping and mining operations; and in use of explosives.

The following list of captains and majors is from that of the Chief of Engineers, with affiliations added:

MAJORS

Parsons, William B., M. Am. Soc. C. E., Consulting Engineer, New York City.
Sewell, John S., M. Am. Soc. C. E., General Manager, Alabama Marble Co., Gantts Quarry, Ala.
Gillis, Harry A., M. Am. Soc. M. E., Mechanical Engineer, Washington, D. C.
Mershon, Ralph D., Fel. Am. Inst. E. E., Consulting Electrical Engineer, New York City.
Dwight, Arthur S., M. Am. Inst. M. E., Mining Engineer, New York City.
Arnold, Bion J., M. Am. Soc. C. E., Consulting Engineer, Chicago, Ill.
Sutton, Frank, M. Am. Soc. C. E., Geographer, United States Geological Survey, Washington, D. C.
McGuire, James C., President, J. C. McGuire & Co., Engineers and Contractors, New York City.
Smith, Glenn S., Washington, D. C.
Finney, John H., M. Am. Inst. E. E., Aluminum Company of America, Washington, D. C.
Waitt, Arthur M., M. Am. Soc. C. E., Consulting Engineer, New York City.
Hunt, Conway B., M. Am. Soc. C. E., Engineer of Highways, District of Columbia, Washington, D. C.
Jonah, Frank G., M. Am. Soc. C. E., Chief Engineer, St. Louis & San Francisco R.R., St. Louis, Mo.
Dennis, William F., M. Am. Soc. C. E., Consulting Engineer, Washington, D. C.
Williams, Gardner S., M. Am. Soc. C. E., Consulting Engineer, Ann Arbor, Mich.
Ostrup, John C., M. Am. Soc. C. E., Consulting Engineer, New York City.
Poole, John H., Assoc. M. Am. Soc. C. E., Detroit, Mich.
Tracy, Evarts, Architect, New York City.
Stern, Eugene W., M. Am. Soc. C. E., Chief Engineer of Highways of Manhattan, New York City.
Molitor, F. A., M. Am. Soc. C. E., Consulting Engineer, New York City.

CAPTAINS

Maxfield, Howard H., M. Am. Soc. M. E., Master Mechanic, Pennsylvania R.R., Pittsburgh, Penn.
Reimer, Arthur A., Assoc. M. Am. Soc. C. E., Engineer of Water Department, East Orange, N. J.
Whitted, Thomas B., M. Am. Soc. M. E., Mechanical Engineer, Charlotte, N. C.
Lyon, Leon E., M. Am. Soc. C. E., United States Assistant Engineer, Norfolk, Va.
Allen, Walter C., Assoc. Am. Inst. E. E., Secretary, Public Utilities Commission, Washington, D. C.
Clarke, Thomas C., M. Am. Soc. C. E., President, Industrial Service Corporation, New York City.
Lawson, William M., Assoc. M. Am. Soc. C. E., Assistant Engineer, Board of Water-Supply, New York City.
Robison, Charles D., M. Am. Inst. E. E., Forstall & Robison, Consulting Engineers, New York City.
Quinby, Edwin R., M. Am. Soc. C. E., Chief Engineer, Consolidated Telephone and Electric Subway Co., New York City.
Davis, Chandler, M. Am. Soc. C. E., Consulting Engineer, New York City.
Chaffee, Robert W., New London, Conn.
Taylor, James L., Jr., Pittsburgh, Penn.
Curfman, Lawrence E., Assoc. M. Am. Soc. C. E., City Engineer, Pittsburg, Kan.
Talman, John T., Washington, D. C.
Gifford, George H, Jamaica, N. Y.
Hilder, Frazer C., Assoc. M. Am. Soc. C. E., Assistant Engineer, Office of Indian Affairs, Washington, D. C.
LaCroix, Morris F., M. Am. Inst. M. E., Mining Engineer, Cleveland Cliffs Iron Co., Ishpeming, Mich.
Hobson, George F., Chevy Chase, Md.
Boyatt, Lynn C., Bowling Green, Ohio.
Matlaw, Isaac S., Assoc. M. Am. Soc. C. E., Assistant Engineer, Public Service Commission, New York City.
Hogan, John P., M. Am. Soc. C. E., Division Engineer, Board of Water-Supply, New York City.
Barker, Harry, M. Am. Inst. E. E., Associate Editor, "Engineering News," New York City.
Kane, Irving P., Assoc. M. Am. Soc. C. E., Assistant District Engineer, International Joint Commission, Gittings, Md.

Timber Bridge Floor Fires with Special Reference to McKinley Bridge Fire

By Hermann von Schrenk*

For the second time within the last three months a part of the roadway of the McKinley bridge at St. Louis burned on Feb. 15, as noted in *Engineering News*, Feb. 22, 1917, p. 332. In view of the frequent occurrence of these fires, a careful inspection was made of the bridge the day following the last fire in order to ascertain the cause, if possible.

It was found that both the fire last fall and the one which occurred last week seemed to have originated under-

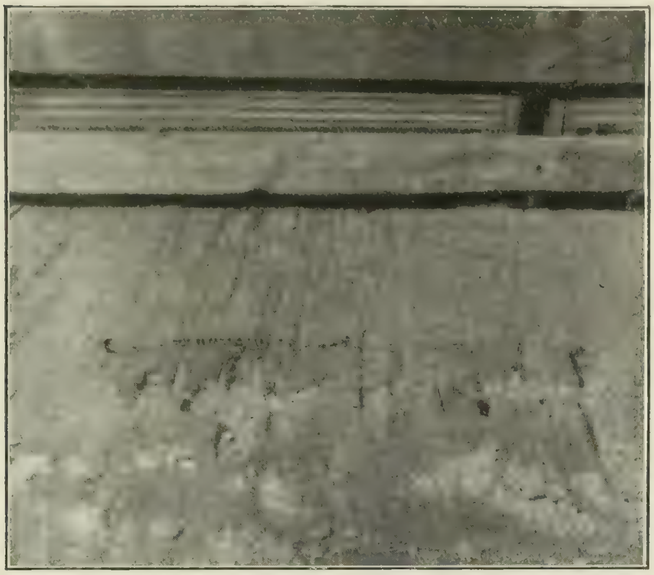


FIG. 1. McKINLEY BRIDGE FLOOR, SHOWING WEAR

neath the driveway. The driveway is constructed of 8x16-in. creosoted stringers, over which hardwood slats 1 in. thick were laid on edge. When first noticed, smoke was pouring out from both underneath the bridge and through cracks in the hardwood slats. An examination showed that the creosoted stringers were blazing, and, in order to get at the fire, it was necessary to rip up a considerable number of the hardwood sections. A careful examination showed that in both fires the only portion of the driveway which burned to any extent were the creosoted stringers. The hardwood slats lying immediately above the stringers were practically untouched.

The fire obviously started at one point and rapidly progressed eastward between the individual stringers for a very considerable distance. There was a strong west wind blowing at the time. A careful examination of the entire situation leads to the following conclusions:

The fire undoubtedly originated at the top, because there is no navigation in the ice-filled river at the present time. Many of the slats are broken at the ends, due to the heavy traffic, so that numerous holes occur in some of them all the way through; in other cases, only partially through. Many of these holes are filled with chips and slivers of wood, dry manure, and other highly inflammable material, as indicated in the attached views. It is conceivable that a lighted match or burning cigarette or cigar stub would set fire to the débris in one of these holes.

*Consulting Timber Engineer, St. Louis, Mo.

This material need not necessarily have burned, but owing to its punky condition probably glowed. It should be mentioned, incidentally, that all of this material was very dry, because there had been no rain for a week or more. A hot glowing mass in one of these holes would rapidly have progressed to the bottom of the slats and set fire to the timbers underneath.

The ignition of the timbers underneath was undoubtedly favored by the strong air current which blew between the individual series of stringers from the west to the east. The construction was of such character that the stringers practically formed a series of continuous flues, because between every I-beam and the lower space of the slats there was a considerable space, affording direct communication between two sets of stringers placed end to end. It is a well-known fact that a flame started on a flat surface will work through a nail hole or other crack, particularly if a strong wind is blowing under the surface. The writer has witnessed this during the last months in connection with experiments made with roof fire tests, in which a burning brand will invariably communicate the fire to the roof boards underneath wherever a nail hole or other crack affords an opportunity. After the stringers had been set afire, it is easy to understand why

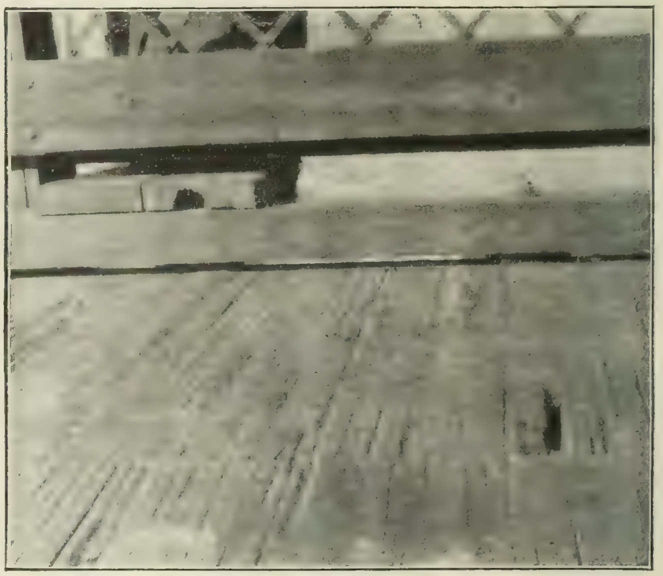


FIG. 2. HOLES AND GROOVES IN TIMBER FLOOR

the fire should have raced across the bridge in an easterly direction.

The point of particular interest in connection with these two fires (both of which occurred in the same manner and with the same results) deals with the relation between the use of timber deck and the fire hazard. After a careful study of these two fires, the writer is of the opinion that the chief reason for the high fire hazard lies in the present method of construction. The hardwood slat deck, with the slats placed on edge, is bound to tear and break. Slats placed on edge under heavy traffic afford the weakest possible resistance, and can in no way be compared to the resistance offered by the same wood when placed so that the wear comes on the end of the fibers, as in the case of wood block. Where such slat construction is used, it should have a solid deck between the slats and the timber beams. According to the writer's opinion, however, these slats should never be used in the form in

which they occurred on the McKinley Bridge. A very much more efficient method of construction consists in building a solid deck and placing regular creosoted wood block on this closed deck. This type of construction is exemplified in the new Municipal bridge across the Mississippi River and the reconstruction of the Manhattan Bridge in New York City.

A number of recent fires on bridges with wooden beams and floors have brought out the criticism in some quarters that the use of wooden construction was not warranted on highway bridges. The writer has examined three such cases during the past year, and in every instance the fire was due not so much to the fact that wood was used as it was to the faulty construction. There is of course no gainsaying that untreated or creosoted timbers will burn when put under conditions where ignition is possible. This, however, is no reason for absolute condemnation of wooden construction. No structural material is perfect, and it is good practice in every instance so to safeguard structural materials that their various defects may cause as little trouble as possible. Where bridges are built of steel, the utmost care is usually exercised in keeping them painted with proper paint, so as to avoid rusting. In the same manner it is misuse of a good material, like timber, to use it where the chances are that it will not serve its best purpose.

In one of the recent fires, the ignition was undoubtedly caused by sparks falling into rotten portions of the roadway and of the substructure. These more or less decayed parts glow and then set fire to the sound wood. The safe practice is to use only properly preserved stringers. This will effectively guard against any decay taking place, which is not only desirable from a strength standpoint, but from a fire-resistant standpoint. These stringers should then be properly protected against ignition from above, where the greatest danger usually occurs. Such protection can readily be given by putting on a solid deck and constructing the roadway of an approved type of creosoted wood block.

Whatever criticism is directed against the timber construction as a matter of policy should be directed against faulty construction and design rather than any inherent quality in the material. Properly designed and constructed bridges of timber construction have stood for many years without deterioration, and the occurrence of fires, such as the one herein described, should be regarded as the exception rather than the rule.

Questions Relating to Engineering Ethics Answered

The American Institute of Consulting Engineers has inaugurated the practice of reviewing and answering questions that may be raised regarding the ethics of engineering practice. These questions are passed upon by the institute's Committee on Professional Practice, which reports to the council; and the latter orders such decisions made public as are believed to be of general interest to the profession. We are indebted to F. A. Molitor, secretary of the institute, for the following answers, approved for publication at the council meeting on Jan. 2.

CASE 1. GUARANTEE OF DATA OF PREVIOUS ENGINEER—An engineer, A, is asked to design, estimate the cost of and construct a bridge, based upon the surveys and data previously supplied by another engineer, B.

Question: Is it proper or wise on the part of A to accept?

Answer: It would be unwise, in view of the responsibility to the client assumed by A, for him to proceed with the work without personally satisfying himself of the adequacy and accuracy of the data supplied by B, unless it were distinctly understood or stated in the terms of A's engagement that he should assume no responsibility for the correctness of the data supplied to him. Such review and verification is desirable in order to protect both client and engineer from the consequences of erroneous data or misunderstood conditions.

CASE 2. COMMISSIONS FOR RECOMMENDING SERVICES—An engineer, A, received a circular letter from a patent attorney, B, asking A to solicit or turn over to B legal work in patent cases and offering to share B's fees with A in such cases. B gives in this letter the names of five engineers as business references.

Questions: (a) Would it be unethical for A to accept and act on B's proposition? (b) Is it unethical for engineers to permit the use of their names as references in business enterprises or for the promotion of business schemes?

Answers: (a) The sharing of fees or profits as compensation for soliciting engagements is regarded among engineers as unethical. This does not apply to the division of fees in cases where two or more engineers are jointly employed or engaged upon the same work. (b) It is regarded as at least imprudent for an engineer to permit the use of his name as a reference regarding the character and responsibility of persons or business concerns for advertising purposes. The practice might lead not only to personal embarrassment, but to the discredit of the profession.

CASE 3. FEE WHEN WORK IS SUSPENDED—An engineer is employed by a client to design, make plans for and superintend the construction of an important work, his compensation to be based upon a percentage of the cost of the completed work. At a certain stage of the progress of the work the client decides or is compelled to abandon or suspend the work, through no fault of the engineer.

Question: Is the engineer entitled to claim and receive the whole amount of the fee which would be due him if the work had gone on to completion?

Answer: Such contingencies should be provided for in the original agreement between engineer and client. In the absence of such a provision and unless the circumstances should warrant a different action, and particularly where the abandonment occurs through no fault or bad faith on the part of the client, settlement upon an equitable basis for the work already done and the expenses and obligations already incurred would be fair and just to both parties.

CASE 4. BIDDING ON PROFESSIONAL WORK—A city, by public advertisement, asked for proposals from engineers to perform certain professional services, the obvious purpose being to secure the services at the lowest possible cost.

Question: Should engineers recognize or take part in such public competitions for services where it is to be presumed that the lowest bidder will be engaged for the services?

Answer: This method of procuring engineering services should be discouraged. It is not regarded as ethical for reputable engineers to enter such competitions. This does not, however, apply to competitions for designs for a specific structure, where such competition is properly conducted and provision is made for reasonable compensation for rejected designs.

The Institution of Civil Engineers of Great Britain, in a recent circular, urges that engineers should not enter into competition at the invitation of municipalities, because of the lack of equity, dignity and proper compensation offered.

CASE 5. ENGINEER'S DUTY TO CLIENT—An engineer was employed by a client to make an investigation and report upon a specific matter relating to the client's business. In the course of the investigation the engineer made discoveries which, while foreign to the subject of his specific engagement, were so related to the business of the client as to be of great importance to him and, if disclosed, might seriously affect that business. These discoveries were mentioned in the engineer's report. The engineer later, at his own expense, pursued the discoveries further, and they appeared to be of great industrial value and scientific interest.

Question: Does the present ethical relation of the engineer to his former client permit him to develop these discoveries for his personal use or profit or to publish an account of them in the interest of science?

Answer: In so far as the case presented involves questions of the proper relations between engineer and client, the committee would reaffirm the broad general principle that the engineer should not make use of information or discoveries, or the results therefrom, obtained while in the service of a client, in any manner adverse to the interests of the client.

News of the Engineering World

Big Paving Contract Declared Void

The Supreme Court of New Jersey has rendered an interesting decision covering contract awards made under certain conditions in setting aside the contract for the improvement of the White Horse Pike, from Absecon to the Atlantic County line, with "Warrenite," recently awarded by the Board of Freeholders to Liddle & Pfeiffer, Perth Amboy, at a cost of \$693,113. This contract was made on Nov. 8, 1916, on condition that it would become void if the Egan Road Bill, providing a fund of \$7,000,000 for the construction of state highways, was approved at the regular election, held simultaneously. This stipulation was later rescinded and the award made final. The Supreme Court, in its decision, holds that the contract had been invalidated by this qualifying provision, saying:

> If such an award can be made to depend upon one condition, why not on two or many? If this condition in the award can be nullified after 16 days at a special meeting, why not after 30 or more days, until the award of the contract will be left in confusion and uncertainty and the legality of the bonds issued to pay the cost impaired? While not aware of any statute or decision that either permits or forbids public contracts to be awarded upon conditions, on the ground of sound public policy contracts so awarded should be declared void.

Connecticut Engineers' Society Holds Thirty-Third Annual Meeting

The Connecticut Society of Civil Engineers is one of the oldest, if not the oldest, of the state engineering societies. At the same time it is steadily growing, its meetings are well attended, and it shows none of the infirmities of age. The success of its annual meetings is partly due to two things: First, the society represents a small state, where access is readily had by a majority of the members to the place of meeting; and second, a definite scheme of conducting the meetings was long ago worked out and has been steadily adhered to.

This scheme involves a 1½-day program—a business session in the morning of the first day, an afternoon session devoted to somewhat elaborate papers or lectures by engineers outside the society and an evening banquet where engineering subjects are taboo. This is followed the next morning by a series of papers and discussions by society members on subjects of local importance. This program has the advantages of variety, compactness and brevity, all of which are distressingly rare in the meetings of most state engineering societies.

In this respect the Connecticut society may well serve as a model for others, but in another it is somewhat behind, due no doubt to the characteristic New England conservatism. The society is only now beginning to realize its obligations and opportunities as a leader of engineering thought in the state or as a public defender and investigator of the profession. The prospect is, however, that in the future this view of the society's function will grow and that such subjects as the justified influencing of legislation, the disciplining of members and the proper use of publicity in engineering matters will receive their due attention.

The thirty-third annual meeting of the society, held in New Haven, Feb. 20 and 21, 1917, was typically good. The outside lectures were on the new Memphis bridge, by Ralph Modjeski; on deep-foundation practice, by James W. Rollins; and on the car-float transfer bridges common to New York harbor, by J. B. French. The local papers comprised a description of concrete construction on Hartford's new water-supply work, by the Chief Engineer, C. M. Saville; on the proposed sewerage system of Bridgeport, by the city engineer, A. H. Terry; on enlarging the Lake Whitney dam at New Haven, by O. H. Marchant; on street-car track maintenance, by P. N. Wilson, of the Connecticut Co.; and a paper entitled "Some Problems of an Engineer in Public Service," by C. J. Bennett, who occupies the position of Highway Commissioner of Connecticut, a position hitherto held by non-engineers. Mr. Bennett's paper was particularly good in that it corrected the all too current impression among engineers that an engineer will make an efficient public executive merely because he is an engineer.

As an extension of the military census now under way in Connecticut, the meeting recommended that the society make for its own files an engineering census of the state, so that in case of necessity the War Department could obtain on short notice a list of all the engineers in the state, together with their specific qualifications for military or engineering duty. The president elected for the ensuing year is Henry R. Buck, of Hartford. The secretary is J. Frederick Jackson, of New Haven.

Indiana Water-Works Men Convene

The tenth annual meeting of the Indiana Sanitary and Water-Supply Association was held at the Claypool Hotel, Indianapolis, Feb. 14 and 15, 1917. An effort was made to increase general discussion by four round table topics on "Water-Works Accounting," "Surreptitious Use of Water," "Distribution System Extensions" and "Meter Department Operation."

Fire protection systems were considered the most flagrant cause of water stealing. Large amounts of unpaid-for service were cited, mostly brought about by the over-anxiety of some boiler room employee to reduce operating costs. J. B. Marvin discussed fire fighting methods in Indiana, a subject of particular interest at the present time because of pending legislation to standardize hose-threads over the state. Of 210 organized fire forces in the state only 16 are equipped with hose and hydrants of standard dimensions.

Judge Clark, of the Indiana Public Service Commission, in discussing "How Shall a Utility Prepare for Future Demands?" pointed out the need of a large working capital at the present in laying in large coal supplies. Mains and services should be laid in advance of street improvements. Investigations were advised looking to

future sources of water-supply; but the proviso was made that where these consist of land the natural crop return will often pay the interest charge and when the property is later put into use as a part of the system it can be capitalized at the appreciated value.

H. E. Garman, in discussing "Recent Decisions of the Public Service Commission," stated that the Commission is doing all possible to encourage metered service. A ready-to-serve charge for private fire protection is established in all cases. A total of $14,000,000 water-works property was appraised by the Commission in 1916.

In a paper on "Weekly Reports of Water Plant Operation to the State Board of Health," John C. Diggs stated that these are of value in showing waste of chemicals as well as under-treatment. These reports were first ordered in November, 1916, and show daily pumpage, chemicals used, total bacterial count at 37° and B. Coli on the finished water.

Paul Hansen, of the Illinois State Board of Health, in recommending state control of water and sewage plants, recommended an extension of bonding limits wherever necessary to provide for purification-plant construction.

R. A. Butler, discussing "A Method of Financing Sanitary Improvements," emphasized the fact that the water-supply companies were behind both gas and electric utilities in methods of getting new business. The sale of toilet fixtures, washing machines, etc., are just as legitimate part of the water business as stoves in the gas business or lamps in the electric business. In a city like Indianapolis, where the large number of open privies is a menace to public health, the great barrier in the way of their eradication is the cost to the property owner—often struggling to meet payments on his property. A funding company was proposed that could sell sanitary fixtures on the easy-payment plan—leasing them to the property owner, with privilege of removal upon non-payment. The payments for water service would be made by the funding company until payment for the fixtures was complete.

The principal officers elected for the ensuing year were: President, W. F. King, Assistant State Health Commissioner, Indianapolis; First Vice-President, D. J. Toyne, Superintendent Water Department, South Bend, Ind.; Secretary, W. G. Ulrich, Indianapolis Water Co., Indianapolis; Assistant Secretary, J. A. Craven, Terre Haute Water Co., Terre Haute, Ind.—From H. E. Jordan, Indianapolis, Ind.

Iowa Engineers on Licensing Fees and Publicity

Two important steps in regard to licenses and standard fees for engineers were taken at the 29th annual meeting of the Iowa Engineering Society, held Feb. 21-23 at the Iowa State College, Ames, Iowa. A resolution was passed indorsing a bill now being promoted for licensing the practice of civil engineering.

The bill specifies that this includes mechanical, mining, industrial and electrical engineering and land surveying, and "any branch of the profession of engineering other than military or architecture." A board of examiners is provided. Licenses are to be issued only for certain branches of work, but an additional license for other branches may be given (without further examination) if the candidate produces evidence of his qualifications. A broad-minded provision is that the board must keep in touch with the requirements for license in other states, and issue licenses without examination to licensed engineers from states whose requirements are not lower than those of Iowa.

The other action mentioned was in adopting the report of the committee on ethics and fees, which presented a schedule of minimum charges for different classes of engineering work. It was pointed out that in many cases public boards or officials claim that they have no knowledge or information as to the value of engineering services. A schedule of charges would be useful in such cases. In this connection there was considerable discussion as to means of educating the public as to the real purpose and importance of the engineer and his work. Publicity, largely through the local press, was urged, but it must be recognized that the editors and reporters are not posted on these matters and are apt to give much more consideration to the political than the technical side of public affairs. Therefore it is for engineers themselves to see that proper and adequate information is prepared and given out.

Apart from these questions, municipal engineering and administration were most prominent at the proceedings of the meeting. A systematic method of naming streets and numbering houses was outlined by C. H. Young (Muscatine), and an interesting address on the commission-manager plan of city government was given by O. E. Klingaman (State University of Iowa). A paper on the water-works situation and proposed new municipal water-supply system for the city of Clinton (26,600 population) was presented by J. G. Thorne, city engineer. K. C. Gaynor (Sioux City) was elected President; J. H. Dunlap (Iowa City) is Secretary.

Activated-Sludge Tests at Pasadena

An experimental activated-sludge plant was put in operation on Feb. 1 at Pasadena, Calif., to make studies with a view to the production of an effluent that can be disposed of on the projected joint sewage-disposal farm for Pasadena, South Pasadena, and Alhambra. The aërating chamber has a capacity of 50,000 gal. a day, with 4 hr. aëration. There are two settling tanks, a sludge pump and a sludge-aërating tank. The aërating tank has 60 ft. of channel and contains 21 filtros plates. Air is supplied by a No. 1 Nash blower.

R. V. Orbison, City Engineer of Pasadena, writes regarding the experiments as follows:

At present I am activating my sludge and hope within a few days to be able to start the cycle. Inasmuch as the sewage effluent on our new farm will be used for irrigating various crops we will not have to treat the sewage to a high degree. Consequently our testing plant will show how much air is necessary to secure an effluent of varying degrees of purification, and knowing the amount of air necessary we can then readily calculate the cost of a plant large enough to handle from 3,000,000 to 6,000,000 gal. of sewage daily. I intend to run my tests with various amounts of air and for various periods of aëration.

Mr. Orbison reports that so far the results have been very gratifying, nitrate having been formed and the sludge being in good condition. He says he expects to make a test of a Brosius plant on lines similar to the one at Hermosa Beach, Calif., described in *Engineering News* of Nov. 9, 1916. He also intends to run activation tests on the effluent from an Imhoff tank.

Schenectady Pipe Joints To Be Welded Electrically Inside

Contracts have been let by the Bureau of Water of Schenectady, N. Y., for electrically welding the circumferential joints of 10,200 ft. of 36 in. lock-bar steel-plate pipe put down by a local contractor. The specifications for this work were described in *Engineering News*, Feb. 15, p. 291; bids were asked on inside and outside welding by oxyacetylene and electric methods. The contract was let at $18,336 to the Commercial Welding Co., of New York City, and is for 137 joints in $\frac{5}{16}$-in. plate and 244 joints in $\frac{3}{8}$-in. The bid was based on experimental runs, as no such job as this has been done. By inside welding the cost of excavation is eliminated. Two bids were in for inside welding by oxyacetylene apparatus, one of $11,156 and one at $52,655. The smaller figure was discarded as being impossible. Specifications for the work were abstracted in *Engineering News*, Feb. 15, 1917, p. 291.

Flood Control Bill Goes to President

On Feb. 26 the Senate passed the Humphreys' flood-control bill which had in an earlier session passed the House in practically identical form. The immaterial changes in the bill have now to be accepted by the House and the whole approved by the President before becoming law. This very radical departure from the previous method of taking care of the river control appropriates $45,000,000 for the control of floods on the Mississippi and $5,600,000 for similar work on the Sacramento River. The former work is to be under the direction of the Mississippi River Commission and the latter under the California Débris Commission. Not more than $10,000,000 is to be spent on the Mississippi nor more than $1,000,000 on the Sacramento in any one year, and none of the money appropriated for the Mississippi can be used in the construction or repair of levees unless assurances have been given that the "local interests protected" will contribute a sum equal to at least one-half the amount allotted by the commission.

A 25,000-Gal. Wooden Water Tank Burst at Springfield, L. I., near Brooklyn, at 10:30 p.m., Feb. 21. The tank was full.

Municipally Owned Utilities in Ohio, except water-works, will be brought under the control of the State Utilities Commission and be compelled to follow the same accounting and reporting system as privately owned utilities if a bill before the Legislature becomes a law.

A New Housing Code for Detroit, Mich., will soon go into effect. It covers the design and construction of new dwellings, limits the lot area that may be built upon and contains various other provisions common to modern housing codes. The code was submitted to Lawrence Veiller, a housing reform specialist, of New York City, before adoption. Dr. William H. Price is health officer of Detroit.

About 100 Miles of Water Pipe will be laid in Detroit this year under the direction of Theodore A. Leisen, general superintendent, Detroit Water-Works. A large percentage of this will be in the 31 sq.mi. of recently annexed territory, including 13 mi. of 48- to 36-in. trunk lines. The estimated cost of all the work is said to be about $2,000,000. The pipe is either on hand or contracted for. In general, the work will be done by force account, but some pipe-laying contracts may be let.

Higher Pay for Municipal Engineers at Indianapolis, Ind., has been urged by B. J. T. Jeup, City Engineer, who has submitted the matter to the City Council. This covers the assistant engineers, levelers, rodmen, etc. A strong argument is made that by reason of the present low pay and the high cost of living the department is losing many of its best men, as private firms offer higher salaries. The result is detrimental to the city's interests and there is good economic reason for the increased pay

The Interstate Bridge Across the Columbia was opened on Feb 14. It connects Portland, Ore., and Vancouver, Wash. The bridge is divided into three sections, the main part crossing the Columbia River and the others Columbia Slough and Oregon Slough. The Columbia River crossing consists of 14 spans aggregating 3530 ft. One of these is a vertical-lift span. There were 8500 tons of steel in the structure, and its total cost amounted to $1,750,000. The bridge was built by Clarke County, Washington, and Multnomah County, Oregon, the latter county paying about two-thirds of the total cost.

Plans for the Key Bridge across the Potomac River at Washington, D. C., are to be amended so as to bring the cost of the bridge within the original $1,000,000 appropriation. This amount was granted some time ago, but it was found this year that owing to the rise in prices it would be impossible to build the bridge as designed for less than $1,500,000. Accordingly this amount was asked of the present Congress by the War Department, which has the bridge in charge. There appears to be no prospect that Congress will make the additional appropriation, so, it is reported in the Washington press, the authorities are proceeding on an amended design which it is hoped can be built within the appropriation. The main change is reducing the width of the bridge from 80 to 65 ft.

PERSONALS

W. H. Wood, County Surveyor of Bates County, Missouri, has been appointed County Highway Engineer.

J. R. Comly, Assoc. M. Am. Soc. C. E., of San Diego, Calif., is now with the San Diego & Arizona Ry., Jacumba, Calif.

Searcy B. Slack, Professor of Highway Engineering at the University of Georgia, has resigned to engage in private practice.

C. H. Young, for several years City Engineer of Muscatine, Iowa, has resigned to engage in private practice as a consulting engineer, with offices at Muscatine.

John T. Gephart, Jr., formerly Construction Engineer, Pennsylvania State Highway Department, has been made Road Engineer of Fayette County at a salary of $3600 per annum.

T. C. MacNabb, Assoc. M. Can. Soc. C. E., Division Engineer of the Canadian Pacific Ry. at Moose Jaw, Sask., has been promoted to Superintendent of the Revelstoke division at Revelstoke, B. C.

L. B. Andrus, M. Am. Inst. E. E., formerly General Superintendent of the Indiana & Michigan Electric Co., South Bend, Ind., has been appointed Chief Engineer of the American Public Utilities Co., Grand Rapids, Mich.

Dr. Morton G. Lloyd, F. Am. Inst. E. E., recently Technical Editor of the "Electrical Review," Chicago, Ill., has been appointed Associate Electrical Engineer of the Bureau of Standards, Department of Commerce, Washington, D. C.

J. H. Libberton, Division Engineer of the Promotion Bureau of the Universal Portland Cement Co., Chicago, Ill., has been elected Secretary of the American Concrete Pipe Association, succeeding E. S. Hanson, Editor of the "Cement Era."

John C. Slippy, a former civil engineer of Pittsburgh, Penn., and author of "Telephone Appraisal Practice," has been appointed Chief Cost Accountant of the city at a salary of $4000. He has been connected with the Costs Accounts Bureau of the city for several years.

J. W. B. Blackman, M. Am. Soc. C. E., City Engineer of New Westminster, B. C., has enlisted in the Canadian forces for overseas service. He has been granted indefinite leave of absence. **Harry Stewardson,** Assoc. M. Can. Soc. C. E., has been appointed Acting City Engineer.

P. J. Watson, Jr., Assistant Engineer of the Chicago & Alton R.R., Bloomington, Ill., has resigned to become General Manager of the Mulville-Watson Construction Co., Alton, Ill. This company was recently incorporated and will handle construction contracts of all kinds.

H. Peyton Mobberly, Assoc. M. Am. Soc. C. E., formerly Division Engineer of the Texas & Pacific Ry., has opened offices in Springfield, Mo., for the general practice of engineering. He will specialize in the preparation of data and reports on the value of short-line railway properties.

Ivan Sanders, County Road Engineer of Lewis County, Kentucky, has been sentenced to 18 months in the penitentiary for malfeasance in office. The contractor, Edward Rand, is under indictment. The two are charged with defrauding the county in the purchase of lumber for concrete forms.

H. C. Vensano, M. Am. Soc. C. E., has resigned as Civil and Hydraulic Engineer of the Pacific Gas and Electric Co., San Francisco, Calif., to become associated with John R. and Edward G. Cahill, General Contractors, under the firm name of the Cahill-Vensano Co., 460 Montgomery St., San Francisco.

F. H. Frankland, Consulting Engineer of Lake Charles, La., who recently had charge of the construction of bridges for the Calcasieu Parish Highway Department, is now associated with the firm of J. A. L. Waddell & Son, Consulting Bridge Engineers, Kansas City, Mo., and will have charge of the firm's New York City office.

William S. Morton has resigned as Engineer in charge of work in Arkansas for the Missouri Pacific Ry. to accept a position with Henry Exall Elrod, Consulting Engineer, Dallas, Tex. He is a graduate of the University of North Carolina, class of 1904, and for a number of years was in municipal work in Virginia and the Carolinas.

E. L. West, Assoc. M. Am. Inst. E. E., recently President of the Reading Transit and Light Co. and the Metropolitan Electric Co., Reading, Penn., has been elected President of the W. S. Barstow Management Association, New York City. This is a new corporation which will supervise the management of all public-utility properties controlled by the General Gas and Electric Co., the Eastern Power and Light Corporation and W. S. Barstow & Co., Inc.

Edward E. Loomis, recently Vice-President of the Delaware, Lackawanna & Western R.R., New York City, has been elected President of the Lehigh Valley R.R., succeeding E. B. Thomas. Mr. Loomis began his railway experience in 1883 as a secretary to the Attorney of the Denver & Rio Grande R.R. From 1884 he was a secretary and clerk to various operating officials of the New York, Lake Erie & Western R.R. until 1894, when he became Superintendent of the Tioga division of this railway. He went to the Delaware, Lackawanna & Western R.R. in 1899 as Superintendent in charge of its mining interests.

OBITUARY

Willard S. Robbins, for the past 25 years with the United States Geological Survey, died recently at his home in Washington, D. C., aged 56 years.

James Terry, President of the Terry Steam Turbine Co., Hartford, Conn., died at his home in that city Feb. 3, aged 44 years. He was graduated from Sheffield Scientific School, Yale University, in 1895. He was a son of the late E. C. Terry, inventor, and founder of the company.

John J. Burleigh, Vice-President of the Public Service Corporation of New Jersey, died Feb. 18 at his home in Merchantville, N. J. He built the first electric street railway in New Jersey at Camden in 1890, and was the organizer of the Camden Light and Heating Co., which was taken over by the Public Service Corporation.

ENGINEERING SOCIETIES

AMERICAN CERAMIC SOCIETY.
Mar. 5-8. Annual meeting in New York City. Secy., Edward Orton, Jr., Columbus, Ohio.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Mar. 5-10. Annual meeting in New York City at McAlpin Hotel. Secy., T. A. Randall, Indianapolis.

CENTRAL ELECTRIC RAILWAY ASSOCIATION.
Mar. 8-9. Annual meeting in Indianapolis. Secy., A. L. Neereamer, Indianapolis.

NEW ENGLAND RAILROAD CLUB.
Mar. 13-17. Annual meeting in Boston. Secy., W. E. Cade, 683 Atlantic Ave., Boston.

VERMONT SOCIETY OF ENGINEERS.
Mar. 14. Annual meeting in Burlington, at Hotel Vermont. Secy., G. A. Reed, Montpelier.

WISCONSIN ELECTRICAL ASSOCIATION.
Mar. 15-16. Convention in Milwaukee. Secy., George Allison, First National Bank Building, Milwaukee.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 20. Annual meeting in Chicago at Coliseum. Secy., C. W. Kelly, Kelly-Derby Co., Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 21-22. Annual meeting in Chicago. Secy., Horace H. Clark, 1325 Edison Building, Chicago.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 20-22. Annual meeting. Congress Hotel, Chicago. Secy., E. H. Fritch, 900 South Michigan Ave., Chicago.

ST. LOUIS RAILWAY CLUB.
Apr. 13. Secy., B. W. Frauenthal, Union Station, St. Louis.

DETROIT ENGINEERING SOCIETY.
Apr. 21. Secy., D. V. Williamson, 46 Grand River Ave., W., Detroit.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
Apr. 26-28. In Dallas. Secy., H. S. Cooper, 405 Slaughter Building, Dallas, Tex.

The United States Good Roads Association will hold its 5th annual convention at Birmingham, Ala., Apr. 17 to 20, during which time a good roads show of machinery and materials will be held.

The Texas Town and City Planning Association held its annual convention in Sherman on Feb. 9 with an attendance of about 300. The officers elected are: President, Edward H. McCuistion; secretary, J. E. Surratt.

Michigan Engineering Society—The officers for 1917 elected at the recent annual meeting are as follows: President, T. O. Williams, Grand Rapids; vice-president, E. D. Rich, Lansing; secretary, W. W. Cox, Kalamazoo, Mich. The next meeting will be held at Grand Rapids, Mich., in January, 1918.

The American Concrete Pipe Association at its annual meeting on Feb. 15 elected as secretary, J. H. Libberton, 210 South La Salle St., Chicago. Mr. Libberton is division engineer of the promotion bureau of the Universal Portland Cement Co., and succeeds E. S. Hansen, editor of "The Cement Era," who has been secretary of the Association since 1913, when it was formed.

The New Jersey Sewage-Works Association held its first annual meeting at the State House in Trenton on Feb. 16. Forty municipalities were represented and addresses were made by Governor Edge, Rudolph Hering, Clyde Potts and Chester G. Wigley. The officers elected were: President, John R. Downes, Plainfield; vice-presidents, I. Z. Collings and Paul Monitor; secretary, Frederick T. Parker, Atlantic City.

The Engineering Association of Nashville has opened its new quarters in the Commercial Club Building, with the office of the secretary and a technical reading room. The association holds weekly luncheons at 12:30 p.m. Mondays, with the exception of the first Monday in each month when a dinner is held at 6:30 o'clock, followed by a business meeting at 7:30. Visiting engineers are always welcome at these events and at the association's quarters.

The Ohio State Association of Contractors has been organized in Columbus, Ohio, with a membership of about 200. H. E. Culbertson, of Cleveland, is president, William Graham vice-president, and William E. Minshall, general counsel. The purpose of the organization, it is stated, will be to procure uniform contract specifications and methods of contracting, to develop friendly relations among contractors and to educate members and public in matters pertaining to contracting.

The American Institute of Mining Engineers held its 114th convention in New York City on Feb. 19. The importance of Brazil as a producer of manganese ores since the outbreak of the European war was pointed out, it being stated that manganese is one of the few important metals not produced in the United States in quantity commensurate with the demand, and that there is now being imported about 300,000 tons annually. Prior to the war India and Russia furnished the greater part of the American supply. In the evening a reunion celebration was held in the Engineering Societies Building. Philip N. Moore was elected president, having received 1205 votes against Sidney J. Jennings' 1010.

A Drainage Conference is to be held at the University of Illinois (Department of Civil Engineering), Urbana, Ill., on Mar. 13-15. This is the second annual conference and is designed to interest engineers, drainage officials, landowners and others in the reclamation of swamp and overflowed lands and the control of floods. The subjects to be discussed include the organization and financing of drainage districts and the construction of such works as ditches, tile drains, levees and pumping plants. It is stated that while about 3,000,000 acres of uplands have been drained in Illinois, there remain great areas of overflowed lowlands along the rivers, aggregating an area greater than that of Holland, the reclamation of which could add $150,000,000 to the land values of Illinois.

The American Institute of Weights and Measures, organized a few months ago as a defensive measure of manufacturers against the adoption of the metric system in the United States, elected a full staff of officers on Feb. 19. The president is W. R. Ingalls, editor-in-chief of "Engineering and Mining Journal"; vice-presidents, Henry D. Sharpe and D. H. Kelly; treasurer, W. M. McFarland; commissioner and secretary, F.

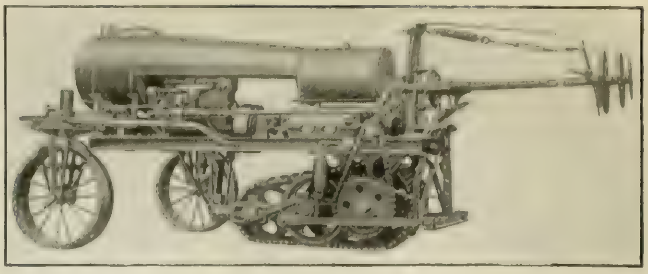
A. Halsey. The annual dues of the association members are $100 for associations national in scope and $25 for all others. The dues of corporation members employing less than 500 employees are $25, and for those employing more than 500 and less than 1000, $50, increasing at the rate of $25 for each additional thousand employees up to a maximum of $500. The annual dues of individual members are $5. The manufacturers believe that the enforced introduction of the metric system would be a calamity. Gages and patterns would have to be changed, while most of the data at present compiled on costs, etc., would be valueless.

The Western Society of Engineers held a Washington meeting in Chicago on Feb. 19, at which papers were presented on engineering work and conditions in George Washington's time. Such a meeting is to be held annually as a patriotic and historical event for engineers. In the future it will be the occasion for the presentation of the "Washington Award," established in 1916 by John W. Alvord, who has given $1000 for the purpose. C. B. Burdick stated that municipal waterworks were built in Boston in 1652; Bethlehem, 1754; Providence, 1772, and Morristown, N. J., 1791. In 1800 there were 16 municipal plants and in that year the first steam pumping plant for water-supply was installed in Philadelphia. City planning began with the early project for laying out the City of Washington. Hydraulic power was confined to overshot and breast wheels for driving grist mills and sawmills, usually requiring less than 10 hp. About 1792 there were numerous projects for canals, and after retiring from the Presidency Washington was interested in the attempt to promote water communication between the Potomac and Ohio Rivers. A short stretch of canal with a lock near Alexandria was planned and built by him. A. N. Johnson presented a paper on road building. In 1790 there were not more than 1800 mi. of post roads, and at about that time broken-stone roads began to be built in this country, but were not introduced into England until 1816. One of the first macadamized roads was built near Alexandria in 1785, and the Philadelphia and Lancaster turnpike was built in 1794, at a cost of $465,000. A military road, built by Washington from Winchester to Wells Creek, Md., could still be traced in 1899. The iron industry in Washington's time was reviewed by James N. Hatch. Most of the finished material produced was pig iron and bar iron. From 1717 to 1770 the production was only 150,000 tons. In addition to the foregoing papers, addresses were made by Ernest McCullough and John G. Kreer on surveying and shipbuilding.

Appliances and Materials

Light Flexible Tractor

The small tractor shown herewith is peculiar in being mounted on a single central caterpillar at the rear end and a pair of caster wheels at the forward end. The controlling handwheels are fitted to a long shaft, so that the operator can ride on the wagon or other trailer. While the machine is intended particularly for agricultural work, it has been used also to operate road drags. It has a four-cylinder gasoline engine, with tubular radiator and with a roller-chain drive to the spring-mounted caterpillar, or "crawler," which has a tread 15 in. wide. The front wheels are 30 in. in diameter, 7 in. wide and are adjustable for a track 45 to 82 in. wide. The machine is 11 ft. long, 8½ ft. wide and 6 ft. high over all. It weighs 5,600 lb. (or only about 4½ lb. per sq.in. of bearing



BATES "STEEL MULE" TRACTOR

surface). The speeds are 2½ and 3½ mi. per hr., with a reverse speed of 2 mi. per hr. The engine can be adapted to run on gasoline, kerosene, distillate or alcohol and is said to give about 30 hp. at the belt or 13 hp. on the drawbar. The machine is called the "Bates Steel Mule" and is built by the Joliet Oil Tractor Co., of Joliet, Ill.

* * *

Corrugated Wire-Glass Sheets

Corrugated wire-glass in sheets, designed for use as translucent roofing and siding sections in connection with corrugated sheets of asbestos concrete, has just been introduced by the Keasby & Mattison Co., of Ambler, Penn. The glass is made in sheets 27½ in. wide and of lengths of from 4 to 10 ft. The depth of corrugation is 1 in.

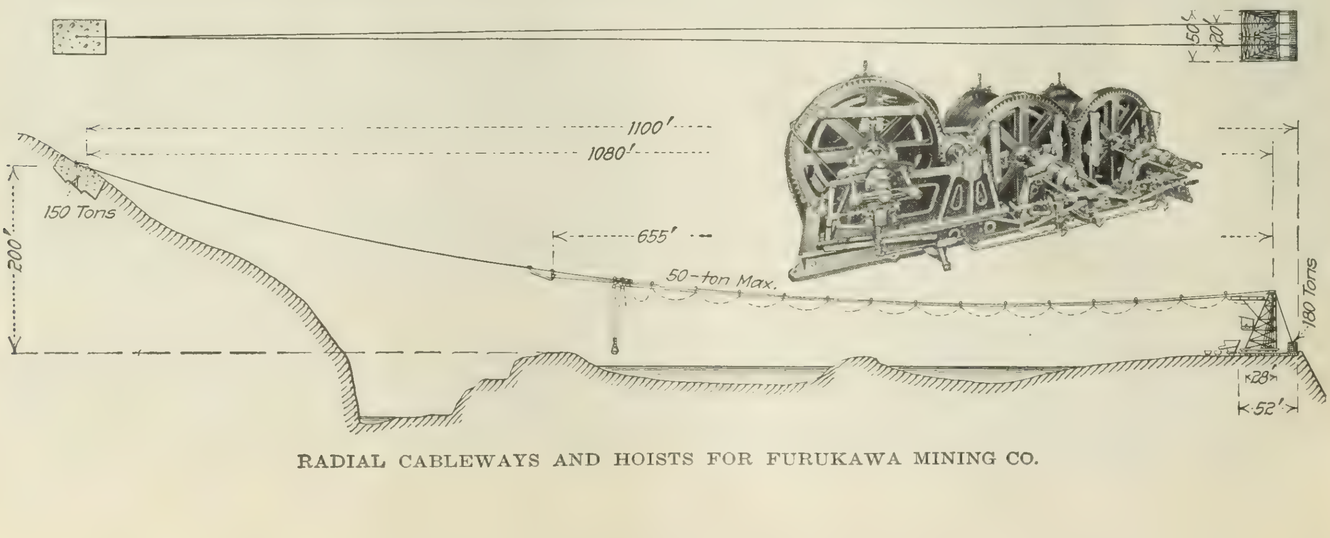
* * *

Long Cableways with Band-Friction Hoists

Two unusual cableways have recently been completed by S. Flory Manufacturing Co., of Bangor, Penn., for the Furukawa Mining Co., of Japan, to be used in reclaiming copper slime tailings flushed from a large mill into a settling basin. The cableways are of a twin radial design having a clear span of 1080 ft., though the carriages are operated over only 655 ft. of the span, as shown in the accompanying sketch. The pair of cableways are designed to move at least 9720 cu.ft. of slime sand per 8-hr. day, hoisting 400 ft. Each carriage and loaded bucket weighs about 8½ tons. A single tower car is used, but it has two towers and two operating platforms. These towers are of wood construction and rise 60 ft. above the track; the car has steel wheels and travels on a steel track (1000 ft. radial movement).

The cables are designed to carry a maximum tension of 50 tons. The main cables are 2½ in., the running and moving ropes ¾ in., the guys 1⅛ in. and the anchorage ropes 1⅜ in. The cable head ends are anchored to the rear of the towers in a 180-ton concrete counterbalance. The tail ends go around separate sheaves and are anchored in a 150-ton concrete block in the hillside. This tail anchorage is 200 ft. above the tower base. One rope line opens and shuts the bucket (a specially built 1½-yd. Hayward Type G clamshell), one line (two-part at the bucket) raises the bucket, and one endless line traverses the trolleys.

Each cableway has a special three-drum hoist with a 200-hp. 500-volt three-phase slip-ring motor with solenoid brakes and magnet control (from the platforms, where the operators have a full view of operations). Each hoist has drums 48 in. in diameter by 42 in. long with band frictions. This is the first application of the Werner band friction (see "Engineering News," Feb. 11, 1915) to cableway hoists. Frictions are worked by mine-hoist air thrusts supplied from a single motor-driven compressor unit. The tower can be moved by a 22-hp. electric hoist winding up ropes running through blocks.



RADIAL CABLEWAYS AND HOISTS FOR FURUKAWA MINING CO.

Engineering News

VOLUME 77 MARCH 8, 1917 NUMBER 10

Combined Concrete Arch Bridge and Concrete Dam

A concrete arch bridge whose abutments form also the abutments of an arched dam was completed a few months ago at La Salle, Ill. The bridge spans a deep gorge between the Starved Rock State Park and the private estate of F. W. Matthiessen, known as Deer Park. The bridge and lake are on his private grounds, but are open to the public.

A dam about 30 ft. high was built in this gorge in 1901, and a lake was formed extending about ½ mile up the gorge. Last summer it was decided to raise the dam 18 ft. higher, making the lake more than twice its original area and about ¾ mile long. This dam forms a crescent with the arch upstream and is approximately 8 ft. thick at the base and 2½ ft. at the top. Its radius on the water side is 48 ft. The downstream face is molded in horizontal irregular ribs, in order to make its appearance harmonize with the stratified sandstone rock that forms the walls of the gorge. In doing this work, forms were placed in the usual manner, except that on the exposed face cotton cloth backed with clay, sand or any similar material was used to form the irregular surfaces seen in the photograph.

One object in raising the dam was to use the lake above for water storage To draw water from the reservoir, three outlet pipes extend through the dam at about 5-ft. intervals. These pipes have an elbow on their outer end and discharge the water on the back side of a molded ledge extending along the face of the dam. The discharge from the pipe cannot be seen from below, but the water will overflow in a thin sheet all along the ledge.

As it was desired to have a bridge to span the gorge near the dam, it was decided to use the abutments of the dam as the bridge abutments. It will be seen from the view that the arch springs apparently from the natural wall of the gorge.

The arch bridge is made up of two ribs 24 in. square at the top of the arch and 2x4 ft. at the abutment, having a radius of 10 ft. The bridge is 16 ft. wide and 160 ft. long on the floor, the span being 70 ft. for the arch rib on the lower side of the gorge and 50 ft. for the rib on the upper side. The foundations are in natural sandstone ledges.

FRONT VIEW OF COMBINED BRIDGE AND DAM, SHOWING IMITATION OF STRATIFIED ROCK IN CONCRETE

The concrete mix was 1 : 2½ : 4, using sand and gravel of ½- to 1½-in. size. Nearly all of it was spouted into place. The exposed surfaces will be finished next spring by rubbing with sand to remove form marks. The formwork consisted of timbers 2x4 in. and 2x8 in., with matched sheathing. The parapet was cast in place, but the spindles were made by hand.

The bridge and dam were designed by O. C. Simonds & Co., landscape gardeners, of Chicago. This firm also contracted to do the work, on the cost-plus-percentage system. The construction was under the charge of F. M. Button, a member of the firm, as resident engineer.

Design and Construction Details of a Long Concrete Arch Bridge

By C. D. Hall*

SYNOPSIS—Describes the general design and the details of construction of a bridge with eight arches of 52- to 88-ft. span. Concrete handled in dump-cars and sometimes placed during severe weather. Interesting notes as to temperature changes in the fresh concrete.

The Morgan St. reinforced-concrete arch bridge across the Rock River at Rockford, Ill., will be completed this spring. It takes the place of an old wood-truss bridge. The new bridge will be 965½ ft. long over all, with a continuous grade of 3% rising from the west end. The main portion comprises eight arch spans—three of 52-ft. clear span, one of 79 ft. and four of 88 ft. Each span has two arch ribs 4 ft. wide, spaced 22 ft. apart. The bridge is 44 ft. 8 in. wide over all, with a 28-ft. roadway and two 7-ft. sidewalks. The latter are carried on cantilever brackets extending out from the spandrel columns. Fig. 1 is a view of three spans at the east end, and Fig. 2 shows the cross-section.

FIG. 1. CONSTRUCTION OF MORGAN ST. REINFORCED-CONCRETE BRIDGE AT ROCKFORD, ILL.

The west approach is a fill 181 ft. long, with retaining walls, followed by a 28-ft. concrete girder span. At the east end are two similar girder spans over the Chicago, Milwaukee & St. Paul Ry. The west abutment and the first two piers are on sandy clay, with no piles. The other piers and the last abutment are on gravelly soil, with pile foundations.

Design, Concrete and Details

In designing the structure the dead-load is taken at 150 lb. per cu.ft. for concrete and 120 lb. for earth-filling. The bridge is designed to carry a uniform live-load of 150 lb. per sq.ft. of roadway and 100 lb. per sq.ft. of sidewalk or a concentrated live-load consisting of a 24-ton traction engine with 16 tons on the front axle and load distributed according to the specifications of the Illinois Highway Commission. The design provides also for a temperature range of 80° F.

The following unit stresses were used: Concrete, 650 lb. per sq.in. in compression; steel, 16,000 lb. per sq.in. in tension, and in compression 15 times the unit stress in the surrounding concrete. For the arch ribs, with temperature stresses included, the unit stress is taken at 800 lb. for compression in concrete and 20,000 lb. for tension in steel. Latticed steel ribs are used in the arch ribs.

The concrete is made with local gravel. A 1:3:5 mix is used for the footings and piers up to the springing line, above which it is 1:2:4 for all the work, except that for the hand railing the mix is 1:1½:3. The washed sand, supplied by the Rockford Sand and Gravel Co., was of the following sizes: 2 to ¼ in. for abutments and retaining walls; 3 to ¼ in. for footings; 2½ to ¼ in. for piers up to sprinkling line; 1¼ to ¼ in. for all parts above springing, except ¾ to ¼ in. for the hand railings, parapets and lamp posts.

The roadway slab is 7 in. thick and has a crown of 6 in. On this will be a 1-in. sand cushion for brick paving laid with tar filler. Expansion joints are provided at the sides of each pier, with three thicknesses of tar paper in both the vertical and horizontal surfaces of the joint. The exposed surfaces of the concrete were not treated in any way, the form marks being allowed to remain. The parapet, or hand railing, is of special design and is poured in place in pressed-steel forms that can be used many times. The bridge will be lighted by 22 electric lamps mounted on ornamental concrete posts on the hand railing.

Construction Methods and Plant

The construction plant consisted of one stiff-leg derrick operated by a double friction-drum hoisting engine; one 3-ton hand-operated stiff-leg derrick; a steam-driven Austin cube concrete mixer of 11-cu.ft. capacity; a Ransome-Bantam gasoline-driven mixer, used to pour the hand rails; four Koppel steel dump-cars of 21-cu.ft. capacity; one single friction-drum hoisting engine; and two 6-in. centrifugal pumps, together with wheelbarrows, drop hammers, piledriver leads, etc. A sidetrack of the

*Assistant Superintendent for the J. J. O'Heron Construction Co., Chicago.

Illinois Central R.R. crosses Morgan St. about 50 ft. from the west end of the bridge. Therefore the cement shed and office were placed here, and all materials were unloaded at this place.

The steam-driven mixer was placed at the west end of the bridge, and a track of 24-in. gage was laid over the old bridge. The cars were operated by a cable from the single-drum hoisting engine placed at the east end of the track. The sand and gravel were wheeled to the mixer in barrows. From the mixer the concrete was hauled up in the Koppel cars by the engine and dumped into chutes placed wherever concreting was in progress. A switch was placed at the mixer, and two trains of two cars each were operated.

The work started on the retaining-wall section; and as it progressed, the old bridge was torn down and the track relaid over the completed spans of the new structure. This process was followed until four spans of the new bridge were in place. Then the mixer was moved to the east end of the fourth span, and the aggregate was hauled by team and spread over the floor of the new bridge in shallow piles. From these it was wheeled to the mixer, whence it was chuted directly into the forms of the next pier and arches. In pouring the roadway and sidewalks of the next span it was necessary to haul the concrete to place in the small cars. When this span was finished, the mixer was again moved to the end of the completed work and this process repeated for each of the remaining spans.

All the reinforcing steel was bent by hand on a bench in the steel yard and delivered to the forms ready to place. The latticed steel arches used to reinforce the arch ribs came in sections weighing about 1000 lb. each. They were lifted into place by the hand derrick, which was carried overhead on the falsework. This derrick was also used in placing the heavy timbers of the falsework shown in Figs. 2 and 3.

The arches of span No. 8 and the east abutment were poured in rather severe weather. At various places in the concrete were placed pieces of tin speaking tube, in which thermometers were inserted for the purpose of taking the internal temperatures. Unfortunately, no systematic record of these temperatures was kept, but it was noticed that the temperature increased from about 65° F. (at which temperature the concrete was placed) for about three days until it reached a temperature of 88° F. It kept this latter temperature for about 48 hr.,

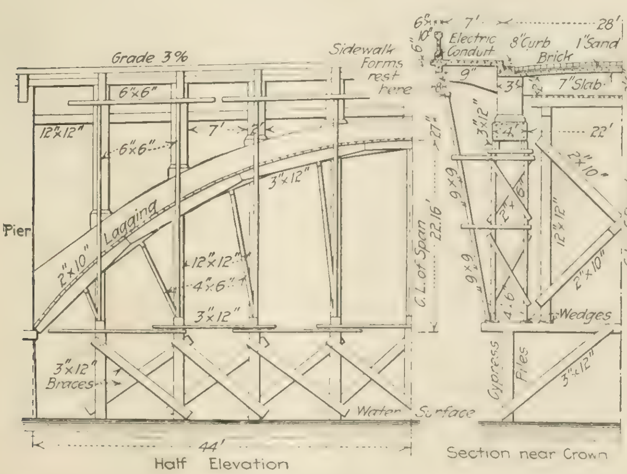


FIG. 2. ARCH CENTERING AND FALSEWORK FOR THE ROCKFORD BRIDGE

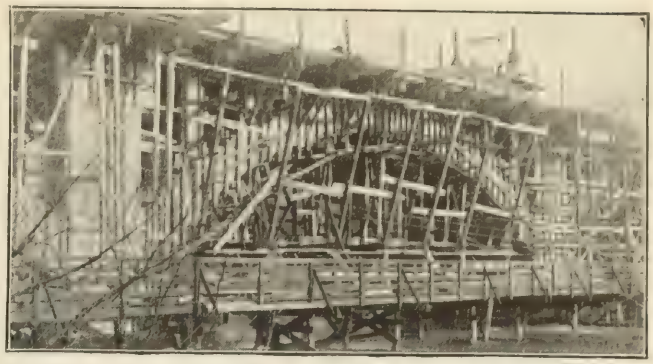


FIG. 3. FORMS AND FALSEWORK OF NEW BRIDGE, WITH TEMPORARY FOOT-BRIDGE BELOW

despite the fact that atmospheric temperatures ranged from 5° to 35° above zero during this time.

Only three piers of the bridge (Nos. 5, 6 and 7) were placed in the stream, the depths of water being respectively 5 ft., 15 ft. and 11 ft. At piers 6 and 7 the excavation was carried down 6 ft. and 8 ft. below the bottom of the stream. This was accomplished by the use of puddle-wall cofferdams, using 3 x 8-in. tongued and grooved sheeting 28 ft. long. The cofferdams were 16 x 39 ft. inside, with a 4-ft. puddle wall.

When the cofferdam for pier 6 was placed, it was found that about 3 ft. of riprap boulders, used to protect the foundation of the old stone pier (which stood alongside the new one) had to be penetrated by the cofferdam wall. The sheeting was set on these boulders as firmly as possible and the puddle wall filled with loam and sandy clay. The 6-in. sand pump was able to keep out the water so that the boulders could be removed, but this was not accomplished until the puddle wall had washed into the dam and been refilled several times. After the boulders were removed, the sheeting was driven down and excavation started. The excavated material was shoveled into a bucket, which was hoisted and dumped by the stiff-leg derrick that rested on the floor of the old bridge.

As the excavation proceeded, the material kept getting finer. It changed from a coarse gravel at the top to a clayey sand at the bottom. This fine material gave considerable trouble by boiling up under the sheeting and in the bottom of the dam and washing in the puddle walls, although the inner sheeting was driven 5 or 6 ft. below the excavation. This trouble was remedied by sand bags placed around the inner sheeting in the bottom of the puddle wall.

All the falsework piles were driven from the floor of the old bridge. After these were in place, the derrick was lowered to the stone pier at the east end of the old bridge and moved back over the falsework piles for the purpose of wrecking the old bridge. This was done with the aid of an oxyacetylene torch, which was used to cut the steel tie-rods and hangers. When the old bridge was closed to pedestrians, a pile foot-bridge was built, as shown in Fig. 1.

The bridge was designed by the Westcott Engineering Co., of Chicago, in conjunction with J. B. Marsh, consulting engineer, of Des Moines, Iowa. It is being built under the direction of Edwin Main, City Engineer of Rockford. The cost will be about $83,500. The John J. O'Heron Construction Co., of Chicago, has the contract for the entire work. Alexander Cross is superintendent in charge for the contractor.

Large Lumber Cableway Controlled by Waterwheels

By J. W. Swaren*

Many excellent stands of timber on the Pacific Slope are in basins not easily accessible by logging railways. A stand of this character in the basin of Spanish Flat, Plumas County, California, is owned by the Spanish Peak Lumber Co. The Western Pacific R.R. passes within 5 mi. of the mill, but a ridge rising to an elevation of 1933 ft. precludes direct rail connection.

It was impossible to build a logging railroad at a cost permitting a profitable cutting of the controlled stand of about 200,000,000 ft. b.m. A proposal to construct a waterwheel-controlled cableway was submitted to the engineers of the American Steel and Wire Co. and the Pelton Water Wheel Co., by whom the design of the cableway was developed.

Cableway Capacity 15 Tons per Hour

The length of the cableway from the main sheaves of the loading station to the discharge station is 27,200 ft. The rated capacity is 15 tons per hour, or approximately 10,000,000 ft. b.m. of rough lumber. The traction cable has a speed of 414 ft. per min., and the loads are spaced 1242 ft., or one load every 3 min. Normal outgoing loads are 1500 lb., an equivalent of 430 to 550 ft. b.m. of lumber, dependent on grade and condition. Each load is supported by two carriers, designed especially for lumber packages.

Each carrier consists of a 4-in. channel, 32 in. long, suspended by chains from an arm attached to a two-trolley cable carriage. A gripper for seizing the traction cable is attached to this arm. Sliding loosely on each chain is a right-angled malleable-iron clamp, for clamping the package. One chain is quickly detachable by a spring-actuated catch under the channel.

The lumber is loaded on buggies in suitable packages and hauled to the loading terminal, where the carriers are quickly put in place by detaching the loose chain, dropping the load clamps into place and reattaching the chain. As the buggy is stopped on a hump, pushing the buggy over the hump leaves the package suspended and firmly locked.

A gong, controlled by the main sheave of the traction cable, enables the dispatcher to space the loads accurately. On the return trip the empty carriers are spaced 621 ft.

*Hayward, Calif.

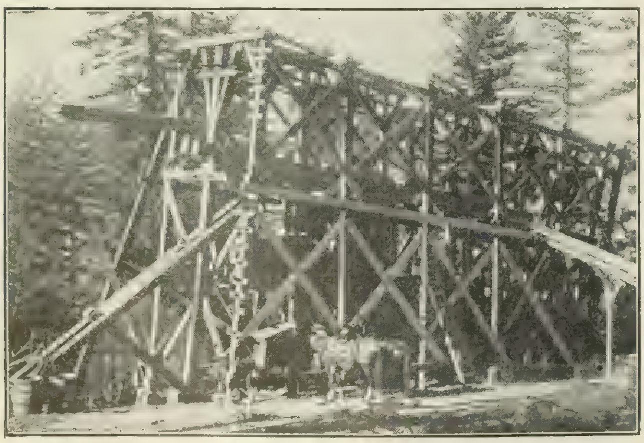


FIG. 1. DOUBLE TENSION TOWER OF CABLEWAY

It has been found that this spacing must be exactly maintained, or the slack of the traction cable will drag on high points. Supplies may be brought from the railway on the return track, the return-load limit being 600 lb.

A steel traction cable 5/8 in. in diameter, with a working tension of 35,000 lb. per sq.in., is used. Its tension is maintained by the customary weighted carriage and multiple-sheave system, installed at the discharge terminal.

The track cables are of lock-joint construction, with hemp center, the loaded track being 1 1/8 in. in diameter and the return 7/8 in. in diameter. It is expected that the track cables will not require renewal during the removal of 200,000,000 ft. of lumber.

Compensation of length for temperature changes is provided for by dividing the track cables into five sections, one end of which is anchored in concrete piers; the other, carried over rocking arms, is held in proper

FIG. 2. TYPICAL ANGLE STRUCTURE

tension by means of a weight box. Rigid rails set in suitable structures provide transition from one section to another.

A double tension tower is shown in Fig. 1. The rigid rails and clearway for loads, as well as the tension chains leading from cable ends to the weight boxes, are in the upper story, while two weight boxes, one for the loaded, the other for the light track, are in the lower story. Cast steel is used for the tension and rocking arms and tension-system sheaves. Chilled-steel idler sheaves carry the traction cable. Guide arms assure proper return of the traction cable to the idlers.

Compensating Arms Used on Vertical Angles

Sixty-five structures are required to support and control the cableway. The average span is 410 ft. between structures, with a maximum span of 2810 ft. Three packages are always on this section. Forty-eight of the structures are standard towers, ranging in height from 12 to 55 ft. Compensation for vertical angles in the track cables is provided by a short piece of rigid track mounted on a pillow block rotating about a tubular crossarm.

FIG. 3. LOADING TERMINAL WITH SPECIAL ROOF

Horizontal angles are deflected by special angle towers, of which there are two. If the angle is small, curved rail structures, of which there are four, are used. A typical angle structure is shown in Fig. 2. Manganese rollers guide the traction cable into the idlers. Two double-bent and two four-bent structures are required for spanning the larger ravines.

Tension is maintained by two double-tension structures (Fig. 1), two double anchorage structures and one combination anchorage and tension station. Special structures are built for the terminals, to shelter the operating force and equipment and to provide suitable tracks for loading and unloading. All structures are designed to permit a package length of 32 ft. This provision resulted in the novel roof design, shown in Fig. 3, of the loading terminal. The overhang covering the cable service tracks had to be constructed as a cantilever, so a very steep pitch was required to prevent an excessive snow load.

As the discharge terminal of the cableway is 890 ft. lower than the loading terminal, computations indicated that not only would the cableway operate by gravity, but an excess of 12 hp. would require absorption by some type of brake. Similar computations indicated a starting torque requiring 20 hp. Operating results have proved these computations reasonably accurate, although due to variations of slack in the track cable, excess power is not developed continuously. Instead, the water-motor set installed as a brake really acts as a governor, in irregular and frequent cycles, alternately absorbing and generating power.

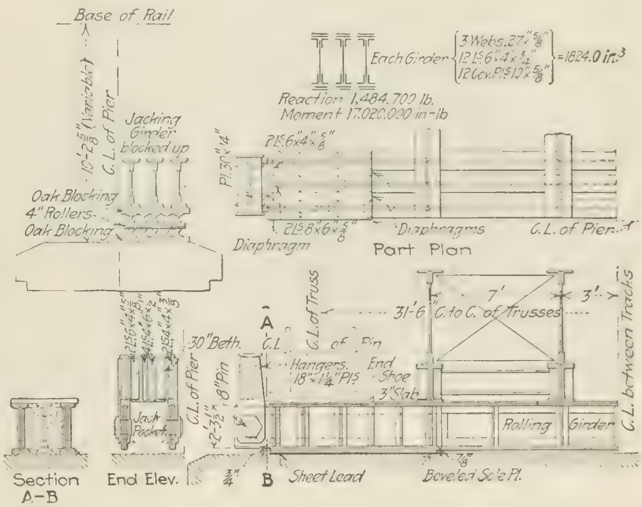
The main, or grip, sheave is 8 ft. in diameter and turns at 16.42 r.p.m. It is fitted with a hand-operated band brake. The vertical shaft of the main sheave is connected by a belt, countershaft and bevel-gear combination to the control unit. This consists of two 24-in. Pelton water motors, rigidly connected in opposition by a solid coupling. The governing is accomplished by needle nozzles, with the needles actuated by direct-motion oil-pressure governors. With the wheels connected in opposition, the buckets of one unit face in the opposite direction to those on the other. The governors are so adjusted that when the cableway slows below normal, water is admitted to the driving unit, and power is developed. When the speed rises above normal, water is shut off from the power wheel and admitted into the braking wheel, and the faces of the buckets (this unit revolves against the normal) strike against the jet, the impact absorbing the excess power of the cableway.

Each governor is supplied with oil by a Pelton positive-displacement pump, belt-driven from the crowned face of the coupling between the water motors. Speed regulation of 10% (5% either side of normal) was guaranteed and has been performed.

Bridge Pier Girders with Beveled Bearing Plates on Masonry

The new main spans of the Union Pacific R.R. bridge over the Missouri River at Omaha rest on heavy distributing girders extending lengthwise along the tops of the old piers. To prevent undesired concentration of the reaction pressure near the ends of the pier masonry, a special form of bearing cushion was placed under these girders.

As described in *Engineering News* of Jan. 18, 1917, p. 122, the four spans (246 ft. 3 in. each, c. to c.) were erected on falsework alongside the old bridge and were rolled into place when the old spans were rolled out. The shoes and pier girders were erected as part of the new spans, and the girders formed the upper roller track. When the new spans were in place on the piers, the



DISTRIBUTING GIRDERS, WITH TEMPORARY JACKING ATTACHMENTS ON OMAHA BRIDGE

girders were again utilized as means for applying the pressure of jacks to lift the spans while removing the rollers, and for lowering the steel work to bearing on the masonry piers below.

The sketch herewith shows one of these girders, and indicates the jacking yoke at the end and the pier bearing plate on the masonry. On each pier are two girders, one for each span, set close side by side. Each girder is made up of three 27-in. plate-girder ribs 34¼ ft. long, connected by transverse vertical diaphragms. The truss shoes rest on it by a 3-in. steel slab extending over all three ribs. The jacking yoke is pinned to end extensions of the two outer ribs; a strong diaphragm just inside the jack pocket transfers the load of the center rib to them.

The bearing plate under each end of each girder is a ⅞-in. steel plate about 9 ft. long, wide enough to take all three ribs. It is beveled ⅛ in. in thickness, being only ¾ in. thick at its outer end. A sheet of lead between plate and masonry furnishes a cushion. The plate being thicker near its inner edge, the load on the masonry is expected to distribute in such a way as to have its maximum intensity at this edge.

The new spans were erected and placed by the American Bridge Co., under the general direction of E. E. Adams, Consulting Engineer, R. L. Huntley, Chief Engineer, and W. L. Brayton, Bridge Engineer, Union Pacific R.R.

Building Bridge Piers in the Mississippi River

By C. F. Womeldorf*

SYNOPSIS—Describes the foundations, with construction methods and plant, of the new cantilever bridge at Burlington, Iowa.

The new highway bridge over the Mississippi River for the Citizens Bridge Co., at Burlington, Iowa, has a cantilever channel span of 180 ft., with anchor-arm spans of 260 ft. each. There are five concrete piers, and some views herewith show different stages in their construction. Three of the piers have pile foundations, while the others are founded on rock. The general design of the two channel piers is shown in Fig. 4. Each consists of a pair of reinforced-concrete pedestals, panelled on three sides and connected by a 12-in. curtain wall, or diaphragm. The two piers for the anchor arms are similar; but one of these (No. 2) is on rock, as is the adjacent smaller pier (No. 1) for the west approach span. The reinforcement is of structural steel. The piers for the east approach (girder and deck-truss spans) are pairs of steel cylinders placed over foundation piles and filled with concrete. The two cylinders are connected by bracing, as shown in Fig. 5.

The substructure was finished Dec. 2, 1916, 10 days ahead of any serious freezing weather, and despite the fact that the long and almost continuous period of high water (from Jan. 10 to July 1, 1916) prevented doing any work in the river early in the season without incurring unusual expense and risk.

Pier Excavation

The excavation for the west pier, No. 1 (founded on solid rock), was carried on by the ordinary cofferdam process. That for Pier No. 2 (also on rock) was done with a 1½-yd. clamshell bucket, a larger area than the size of the crib being cleared off so that it could be set in place on the rock. This excavation was quite troublesome on account of having no orange-peel bucket available to handle the boulders and loose rock overlying the solid rock. And on account of the sand washing in from the upstream side it was necessary to handle quite a little excess material.

No excavation was necessary at Piers Nos. 3 and 5, but at pier No. 3 (channel span) it was found that the bed of the river had scoured out during high water. This was replaced with riprap carried well out beyond the pier. The crib was then landed on the stone. This crib, like all the others and like the tubular piers exposed to the strong current of the river at time of high water, was well protected with riprap. Pier No. 4 (channel span) was first landed in position on the bed of the river, and the sand was then pumped out until it settled to the proper elevation.

Very little excavation was necessary for any of the cylinder piers. It was found, however, that the sand under the surface at the first three of these piers (at the shore end of the east approach) would not sustain the weight of the steel shells. It was therefore necessary to drive four piles at each pair of tubes, crosscap them and frame up under the top strut between the tubes, in order to hold them in position until the concrete could be run.

The cribs and cofferdams were all built in the yard on the Iowa (west) shore. The cribs were built and launched from ways, after which they were towed to their proper positions or tied up until wanted. Fig. 2

Fig. 1

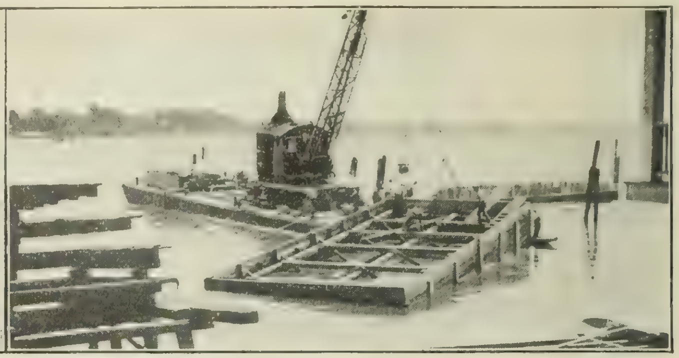


Fig. 2

FIGS. 1 AND 2. LAUNCHING AND HANDLING PIER CRIBS FOR NEW MISSISSIPPI RIVER BRIDGE AT BURLINGTON, IOWA

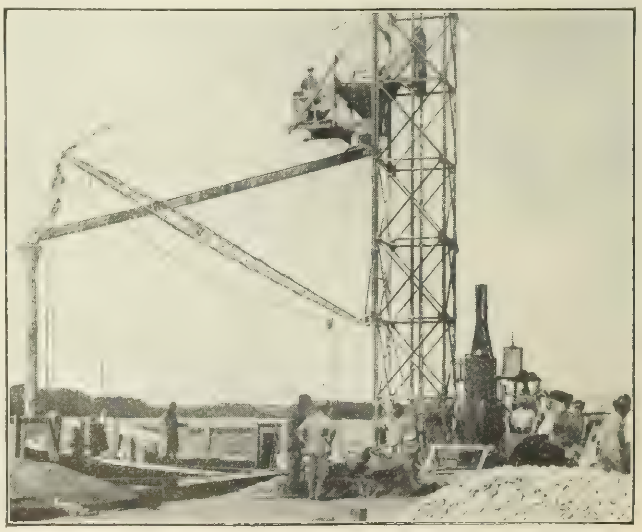


FIG. 3. TREMIE CONCRETING IN CRIB OF PIER 4

*Resident Engineer, Wisconsin Bridge and Iron Co., Burlington, Iowa.

shows this part of the work. The ends and sides of the cofferdams were framed separately, so that they could be used over again where size permitted. These parts were launched from the ways, after which they were floated to place as desired. The cofferdams were made of two

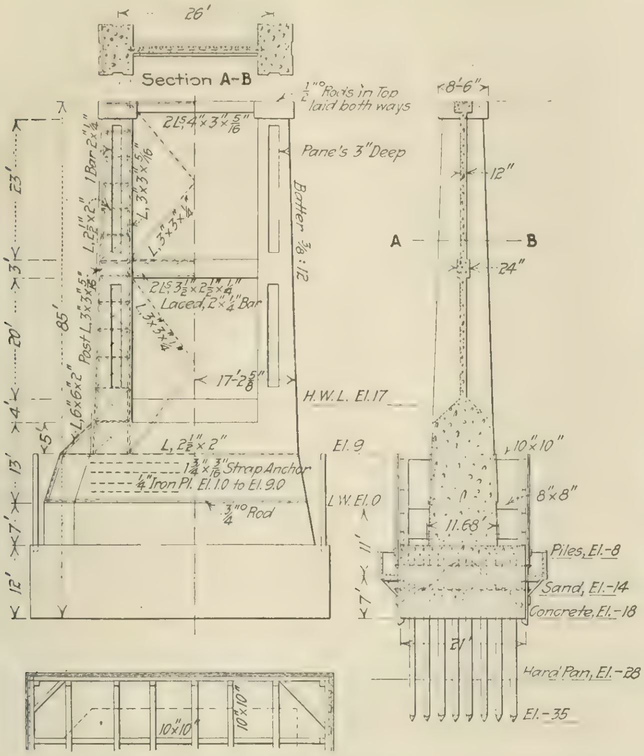


FIG. 4. PIER FOR THE CHANNEL SPAN OF BURLINGTON BRIDGE

Showing the structural steel reinforcement

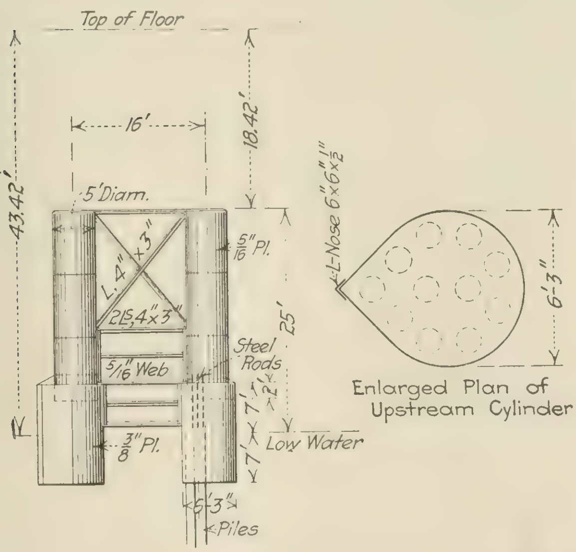


FIG. 5. CYLINDER PIERS FOR THE EAST APPROACH OF THE BURLINGTON BRIDGE

thicknesses of 1-in. lumber with tar paper between. The cribs and all bracing were of 8x8-in. pine.

In sinking the cribs, boxes were built on top of the cofferdams at each end. These were loaded with crushed stone, which was afterward used for concrete. This arrangement was used instead of the stone boxes on the sides, as shown in Fig. 4. The joint between the crib and the cofferdam was made tight by calking with oakum. In each case, however, the material worked loose

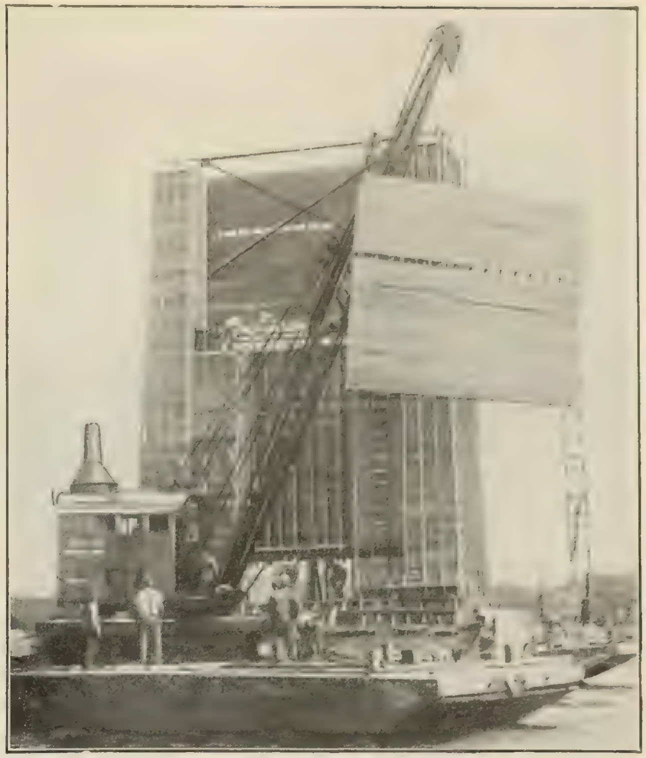


FIG. 6. SETTING PIER FORMS IN LARGE SECTIONS

and the joint opened, so that it was necessary for a diver to go over the calking and stop the leaks when the pumping was started. All the pumping was done with an 8-in. centrifugal pump, which was of more than sufficient capacity.

Each crib was held in position by a cluster of four piles about 10 ft. above and below it, from which cables were fastened to the four corners. The piles were then driven inside the crib, before it was sunk. The cribs floated about 3 ft. above the surface of the water, and after being securely fastened they were used to lay off the spacing for the piles. By this means the pile driving could be done very accurately; and although some of the piles were followed below the surface of the water and skewed off under the crossbracing, no great difficulty was experienced from this cause when the cribs were sunk. It was found that the cribs, when landed on the bottom, were practically in their correct positions.

Driving Foundation Piles

The piles were of timber, 35 to 40 ft. long. The penetration varied from about 15 to 30 ft. They were all driven to sustain a load of 15 tons each, according to the *Engineering News* formula, although some of them brought up very hard and were driven practically to refusal. The sand varies from 8 to 10 ft. deep and is underlain with a blue shale, or hardpan, which is directly on the rock. All the piles were driven well into the shale. A Vulcan special steam hammer, having a stroke of 36 in. and striking parts weighing 3000 lb., was used to do the driving. This hammer was fitted in a steel frame, so that piles could be driven about 4 ft. below the ends of the leads without using a follower.

The pile driving for the tubular piers was all done before the tubes were set in position; and although some of these piles were driven down by a follower to the cut-off level below the surface of the water, very little trouble was experienced in placing the steel tubes in position.

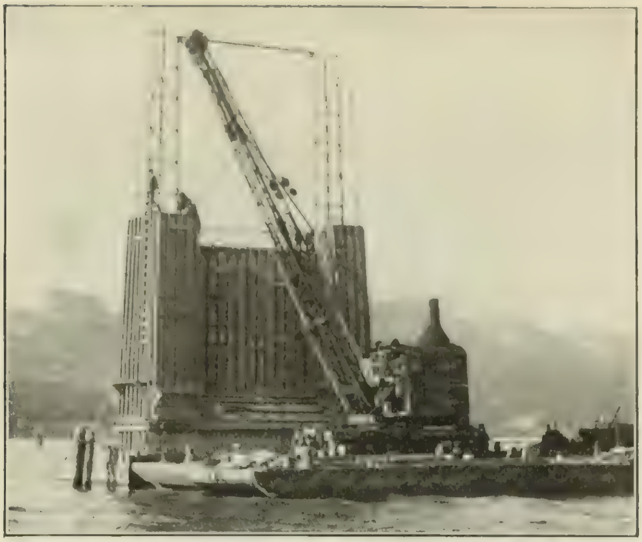


FIG. 7. STRUCTURAL-STEEL REINFORCEMENT OF CHANNEL PIERS

A good deal of triangulation work was necessary, however, and care was exercised to check up the centers as the driving was carried on.

All the concrete below water in the tubular piers, and in the main piers to within 6 ft. of low-water mark, was run through 10-in. tremies of No. 16 galvanized iron (Fig. 3). These were 15 to 30 ft. long. When first used, they were suspended from the boom of the hoisting tower by a line running direct to the drum of the hoisting engine. Later it was found that this direct connection was unsatisfactory; and a pair of double blocks was put in, in order to keep better control of the elevation of the tremie, which had to be gently raised from time to time and at the same time not raised so far as to allow all the concrete to run out of it.

It was sometimes difficult to keep the tremie full of concrete and not run it over, but with the exercise of care and by tapping the side of the tremie this difficulty was soon overcome. The concrete deposited under water was a 1 : 2 : 4 mixture, that above water a 1 : 2½ : 5. The forms were of 1-in. lumber, with 3½x6-in. studding

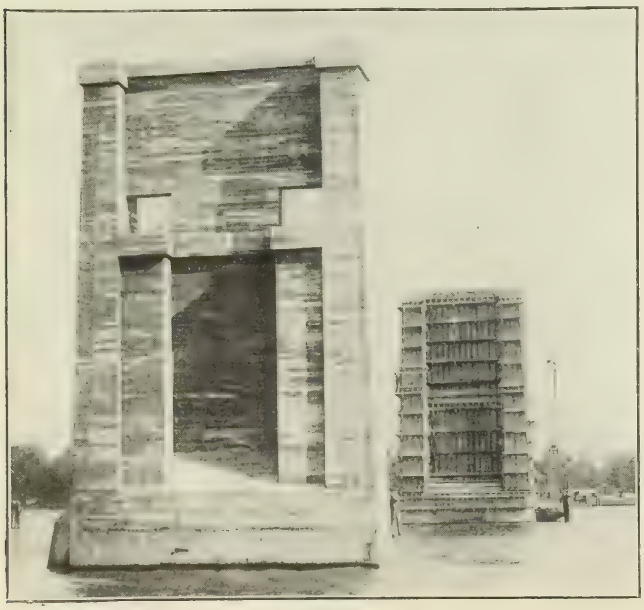


FIG. 8. FINISHED CHANNEL PIER

tied across with No. 10 annealed wire, which was kept tight by using eye-bolts. These bolts were placed between two 3½x6-in. wales spaced about 5 ft. c. to c. As piers Nos. 3 and 4, and Nos. 2 and 5 were alike, the forms were used over again.

Construction Equipment

A 20-ton Browning locomotive crane with a 50-ft. boom was used for handling the cribs and cofferdam, for setting up and taking off the forms and for setting up the pier plates and the structural reinforcing. This hoist was mounted on a track, in the center of a scow 24x86 ft. It was fitted with 60-ft. leads having a 21-ft. reach and was used for all the pile driving. When handling the cribs and setting up the cofferdams, an additional derrick scow having a 50-ft. boom was necessary.

The concrete scow, 19x100 ft., was fitted with a 20-hp. double-drum Lidgerwood hoisting engine, a No. 12 Smith mixer and an 80-ft. Insley tower. The material was all delivered on separate scows, of which there were two 20x110 ft., two 16x60 ft. and one 18x110 ft. The material was wheeled from these scows to the mixer.

The Wisconsin Bridge and Iron Co., of Milwaukee, Wis., is in charge of the design and construction, and the writer is resident engineer for the company. The contractor for the substructure is Adolph Green, Green Bay, Wis.

Worcester's 35-Year Grapple with the Sewage-Disposal Problem

By W. L. Butcher*

Recent agitation to compel Worcester, Mass., to discharge a more highly treated sewage effluent into the Blackstone River (*Engineering News*, Feb. 1, 1917, p. 213) suggests a review of the history of sewage disposal in Worcester for the past 35 yr.

About 1881 the condition of the Blackstone River became such as to lead to a report by the State Board of Health, Charity and Lunacy, which recommended downward filtration through sand.

In 1884 the city engineer visited Europe. In 1886, acting under an order by the City Council, the city engineer made a report recommending chemical precipitation. Definite steps were taken soon afterward, because of an act of the legislature in 1886 directing the city "to remove from its sewage . . . the offensive and polluting properties and substances therein, so that after its discharge into said river . . . it shall not create a nuisance or endanger the public health." Four years were allowed for the completion of the works.

Land was purchased, and the construction of an intercepting sewer was started before a final decision was made as to the method of treatment to be adopted. In 1889 the construction of a series of settling tanks was started and provision made for caring for the sludge, the adoption of further methods of treatment still being held in abeyance. In 1890 the method of chemical precipitation, then so common in Europe, was definitely adopted, and the necessary works for treating the sewage were put into operation on June 25 of that year.

The plant as first constructed had a nominal capacity of 4,500,000 gal. per day and was inadequate for the

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treatment of the entire sewage of the city, because the sewage was mingled with a large brook, the average combined flow being from 12,000,000 to 15,000,000 gal. per day. The city therefore began the enlargement of the plant in 1892, completing it in 1893.

While the enlargement of the plant made it possible to treat all the sewage during dry weather, the large quantities of brook and storm water tributary to the sewer system, together with the growth of the city, so increased the flow in times of wet weather that there were frequent storm overflows of mingled sewage and rain water. Furthermore, although the process adopted was capable of removing nearly all the suspended matter, it could not greatly reduce the dissolved organic matter. In 1895 a suit was brought against the city to secure a more complete enforcement of the provisions of the mandatory statute of 1886.

The result of this litigation was the amplification of the treatment plant and the construction of the "separating system." This system includes intercepting sewers by means of which the sewage can be collected before its discharge into the large brook previously mentioned, and the separation of sewage and also storm water in a substantial portion of the city.

In 1896 a thorough investigation of methods of dewatering sludge was undertaken, including many experiments with a large filter press, to determine the practicability of this machine for dewatering the sludge that had previously been disposed of by running it out into sludge lagoons, allowing it to dry and ultimately hauling it to adjacent farms, at the expense sometimes of the city and at others of the farmers. As a result of these tests a plant for dewatering the sludge by means of filter presses was built and was put into use in 1898.

After prolonged experiments with small sand filters to determine their efficiency under conditions encountered at Worcester the city began the construction of sand filter beds in 1898, to supplement the chemical treatment. The area of these filters was increased gradually until in 1915 it amounted to 72.6 acres.

Legally the city has occupied a unique position with respect to the sewage-disposal problem, because the original statute of 1886 was mandatory and provided that "the Supreme Judicial Court . . . shall have jurisdiction in equity to enforce the provisions of this act, by injunction or by any other appropriate remedy. . . ." In response to the action brought against the city in 1895 the court ordered the city ". . . effectually to remove from its sewage . . . the offensive and polluting properties and substances therein, so that after its discharge . . . it shall not create a nuisance or endanger the public health, and the respondent shall proceed with due diligence in obeying this decree."

The city has made extensive enlargement of the sewage-treatment plant, in addition to the construction of the "separating system," in pursuance of this order. It has been maintained with much confidence, by the city, that the original statute removes it from the jurisdiction of the State Department of Health and that it is acting directly under the jurisdiction of the court and that proceedings against it must be made through the court or by special legislation supplementary to the mandatory act of 1886.

From the beginning of the operation of the chemical-treatment plant, continuous experimental work has been carried out, chiefly upon a very large scale, to determine the practical results of the methods in use for the treatment of the city's sewage, and of all other methods which have been proposed from time to time and which seemed to give sufficient promise to warrant thorough investigation. About the year 1900, when so much attention was being given to septic-tank treatment, one of the large settling tanks was converted into an open septic tank, a large portion of the sewage subsequently to be filtered being passed through this tank, which was continued in practical as well as experimental use for several years. The results of these experiments, as well as numerous others made upon a similar scale, failed to give sufficient promise to warrant the adoption of this method.

In 1904, experiments were begun with contact beds, which demonstrated that this process is capable of effectively treating the Worcester sewage. The results, however, were not sufficiently encouraging to warrant its adoption.

In 1906 the contact beds were replaced by trickling filters of somewhat larger size, built of broken stone. These filters demonstrated their capability of producing a satisfactory effluent and of being entirely practicable for use under the conditions existing at Worcester. Beginning in July, 1911, the sewage applied to them was first passed through an experimental Imhoff tank. The experiments with the trickling filters and the Imhoff tanks were among the most exhaustive of any that have been carried out in this country and included studies of distribution by various kinds of nozzles, leading to the development of the Worcester nozzle. An exhaustive report was made in 1912, covering these experiments and presenting the following conclusion:

> The cost of operation of Imhoff tanks and sprinkler filters, per million gallons of sewage treated, would be very much less than the cost of operation of chemical precipitation or sand filtration as carried on at Worcester.

The results of these investigations are of great local value because of the necessity of soon adopting some of the more modern methods of sewage treatment, as the available land suitable for the extension of the sand filters already is limited in area.

The Worcester sewage-disposal problem has just come to the front again through further agitation by residents of the Blackstone River Valley below the city, who are attempting to secure legislative action requiring a more effective treatment of the sewage. The State Department of Health has filed a report recommending legislative action.

Before deciding upon a definite procedure, however, the city desires to conduct experiments with the activated-sludge process, which has been developed since the experimental work previously described was completed.

The original works were planned and constructed under the direction of the late Charles A. Allen, city engineer, who called in consultation the late Dr. Leonard P. Kinnicutt, of the Worcester Polytechnic Institute, to advise upon the chemical phases of the problem. The extension to the original plant was built in 1892 and 1893 under the immediate direction of Frederick A. McClure, who has been city engineer from 1892 to date. Certain of the information contained in this article has been furnished by Harrison P. Eddy, now of Boston, who had immediate charge of the Worcester sewage-works for about 15 yr. and who was responsible for developments until 1907. He was succeeded by Matthew Gault, who has also kindly reviewed this article.

Building 360 Miles of Roads with County Day Labor

By J. S. Bright, Jr.*

San Bernardino County, California, containing approximately 22,000 sq.mi., is probably the largest county in the United States. It has an assessed valuation of about $60,000,000. In October, 1914, road bonds to the amount of $1,750,000 were voted. This sum was subsequently increased to $1,813,000 by the premium received on the sale of the bonds. Funds were thus provided for the improvement of 87½ mi. of road with concrete pavement, 100 mi. with macadam pavement, and for 170 mi. of oiled or graded desert road.

This work was under the direction of a commission of three members appointed by the supervisors of the county prior to the bond election. As soon as the bonds were approved by the voters, the supervisors made an appropriation from the general funds of the county for preliminary surveying, and plans and specifications were prepared for 30 mi. of road. The bond money was not deposited with the county treasurer until Apr. 1, 1915.

The specifications called for a 1:2:4 concrete pavement 16 ft. wide and 5 in. thick, with an asphaltic oil top. Contrary to the usual California practice, expansion joints were provided (30 to 75 ft. apart). The specifications for the macadam road stipulated one course of crusher-run rock with an asphaltic oiled wearing surface, totaling 16 ft. wide and 5 in. thick.

While the preliminary survey and preparation of the specifications were in progress, the commission advertised for bids on rock, sand, cement, and rock machinery. Each bidder on rock submitted a sample for testing; and because of the variation of weight in different available rocks, the bids were received on a cubic-yard basis. In allotting the contracts for rock, the roads were divided into independent sections controlled by the nearest railroad delivery point, which determined the freight rate and wagon haul. This resulted in the contracts being divided among three firms. One rock accepted weighed 2430 lb. to the cubic yard, another 2650 and a third 3000 lb.

Having three separate sources of supply proved fortunate, because of breakdowns and car shortages. One plant was able to furnish 40 cars of crushed rock per day. The cement contract was awarded to one company, but this company had connections with four railway lines without switching charges.

Bids were received on all necessary small tools, plows, scrapers, graders, wagons, unloading chutes, pipe, mixers and rollers. Most of the time additional equipment was rented; and this practice was generally found as economical as to purchase, when depreciation charges were considered. These preliminary steps enabled the highway commission to organize its first construction crew two weeks after the money was deposited in the county treasury.

Roads Constructed with County Day Labor

The reason for adopting the day-labor plan over the contract system of construction was the result of preëlection promises. The promise had been made to local laborers and teamsters that, if the work could be done by day labor at or near the same cost as under the contract system, one or more day-laborer crews would be organized.

FIG. 1. MOUNTAIN ROAD IN SAN BERNARDINO COUNTY, CALIFORNIA

To test the economy of this method, bids were called for on 15 mi. of road, and three crews on the day-labor plan were employed on 15 mi. of similar road. When the bids were received, they were higher than expected, and only 3½ mi. of the 15 were done by contract. The cost of the work then under way by the county crews indicated that the day-labor plan could be made as economical as the contract system.

The commission then decided to do the remainder of the work by day labor. By following this plan the general business of the county was stimulated, giving the idle population work during quiet times. Of the $1,813,000 expended, it is estimated that at least $1,513,000 passed directly into the hands of San Bernardino County citizens and corporations.

In the organization of the construction crews it was found necessary to maintain camps for the crews on the mountain and desert roads only. In the valleys the jitneys proved a flexible transportation system for the employees. It was generally possible to get plenty of teams within two miles of the work.

*Engineer, San Bernardino County Highway Commission, San Bernardino, Calif.

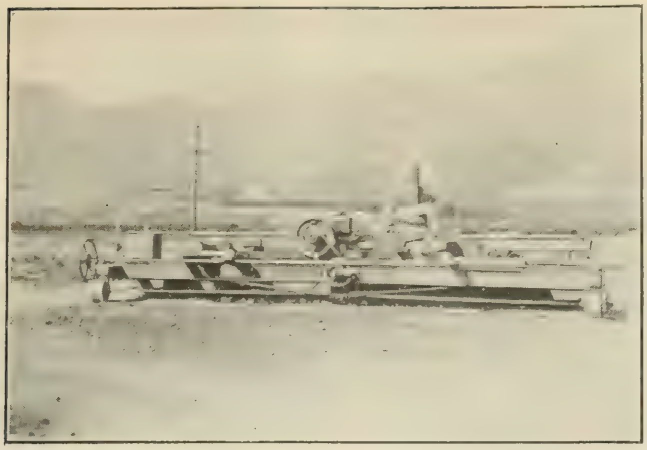


FIG. 2. CARR'S MECHANICAL TAMPER, USED FOR FINISHING 10 MILES OF CONCRETE ROAD

The rock and cement were hauled by teams or trucks, depending upon the lowest bid per cubic yard. The unloading was generally let by contract with the carload as the unit.

Concrete-Road Construction

The organization of a concrete-pavement crew was as follows: One superintendent and timekeeper, one grading foreman, one form setter, one concrete foreman, one mixer operator, one roller operator, two pumpmen, 25 to 40 laborers. Teams were required approximately as follows: Four "4-up" Fresno teams, one "4-up" plow team.

In curing the concrete it was found best in summer to cover it first with about 3 in. of earth. This covering was kept wet for two weeks. The traffic was then turned on for another two weeks, after which about 2 in. of the covering was removed by a road grader. The remaining inch of covering was left on indefinitely until blown away by the wind. This gradually exposed the concrete to the hot sun, but allowed it to dry out slowly. Wherever this method was followed, no trouble was experienced with the pavement buckling.

The method of not covering the pavement, but making small dikes around limited areas and keeping the surface constantly submerged with water, is not good practice in Southern California in hot weather, for the top $\frac{1}{16}$ in. of the concrete takes on a chalky appearance.

A Carr's mechanical tamper was used for surfacing about 10 mi. of the concrete road. This machine was one of the first put out by Mr. Carr, and his later machines are much improved. This method gives a good dense concrete and makes a superior finish in comparison to hand tamping. It is advisable to employ a first-class operator to manage the machine, as most of the difficulties experienced came from inefficient operators.

The asphaltic-oil top was handled by a separate crew, for it was best to turn the traffic on the concrete for several months and thus grind off the laitance before applying the top. The concrete was given two oil coats of 0.25 gal. per sq.yd. each.

Macadam-Road Construction

The macadam construction work was organized under a superintendent who had supervision over three or four crews on separate roads. Each crew had a foreman to attend to the subgrade, rolling and applying the screenings. The superintendent generally had only one grading crew, which he moved from one road to another as circumstances would permit. Wherever there was any considerable quantity of grading, this work was done in advance, to allow the infrequent rains to assist in the settlement of the material.

The rollers were worked to their full capacity by equipping them with headlights and working them three 8-hr. shifts. "Prest-o-lites" were used on the steam rollers, and the gasoline-engine-operated rollers were provided with electric headlights. The current was generated by belting a Ford magneto to the flywheels. These gave a very bright steady light, the flywheels having a fairly constant speed. A roller thus equipped is shown in Fig. 3. A spotlight was riveted to the frame of the steering roll and was thus automatically adjusted to the road.

The construction crews attended to giving the macadam pavement the first coat of oil before it was opened for traffic. Two coats were put on, ranging from 0.4 to 0.5 gal. per sq.yd. The oil used on both concrete and macadam was 90% asphaltic oil, heated to 400° F. and applied by a motor-truck distributor under a pressure of 30 lb. per sq.in. The state oil-heating plant at Etiwanda, San Bernardino County, was used by the commission. This is an uptodate plant in every detail, and the oil was heated for from 1 to 4c. per bbl., according to the amount the truck could handle. The oiling is costing to date from $300 to $400 per mi. per coat, depending upon the cost of sand and screenings.

Promoting Efficiency—Bonuses for Concrete Men, Etc.

Efficiency was promoted and dead timber removed from the organization by careful daily-cost comparison. An efficiency engineer was employed for the first three months. The timekeeper reported to him daily, and each month a careful comparison of unit cost on similar classes of work was made. Proper cost standards were soon established; and if any foreman exceeded the limit, he was given a chance to explain, generally followed with his time.

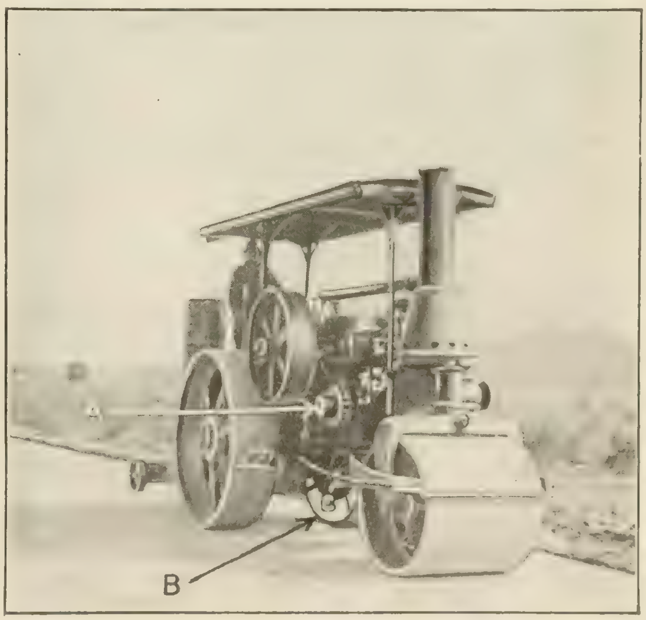


FIG. 3. ROAD ROLLER EQUIPPED FOR NIGHT WORK
A is a Ford automobile magneto; B is spotlight on roller yoke

The commission has employed as many as 10 superintendents at one time, each with from one to four crews under his charge. If portions of the county had been neglected and the operations bunched, five superintendents could have handled the work.

Further to promote efficiency, a bonus was paid to the concrete crews; but they were not permitted to do over a certain amount per day, and the foreman and mixer operator were not allowed to participate in the bonus. These last two were omitted in order that the work would not be improperly done in order to earn a bonus.

The best organized crew, in good weather with no machinery breakdowns, could complete 2 mi. of concrete base per month. The macadam crews, when working with lime rock, could also complete 2 mi. per month.

Savings could probably have been made if small portable sand-washing and gravel-screenings plants had been used from the start. A smaller number of crews would probably have been more efficient; but in public work each community had to be considered, and none wanted to be left until the last.

The completed roads have cost the county from $8800 to $12,000 per mi. for concrete, and $5000 to $10,000 per mi. for macadam. The work has not been completed as soon as expected, because it was found economical to crush with portable crushers some of the rock from field stone on a stretch of about 12 mi. This crushing was done by contract. Otherwise the 187½ mi. of road, outside of the oiling, which is held back for hot weather, would have been completed in 16 instead of 19 months.

Low Hauling Costs—Officials

The greatest saving was made on hauling of material. At the outset a trucking firm made a very low bid per ton-mile, as follows: Up to and including 1 mi., 18c. per ton; 1½ mi., 24c.; 2 mi., 31c.; 2½ mi., 37½c.; 3 mi., 43½c.; 3½ mi., 49c.; 4 mi., 54c.; 4½ mi., 60c.; 5 mi., 65c.; 5½ mi., 69c.; 6 mi., 75c.; 6½ mi., 80c.; 7 mi., 86c.; 7½ mi., 90c.; 8 mi., 96c. per ton.

The firm that took the contract at these prices could not handle all the hauling, but local teamsters attempted a large part at the same price. In some instances the price had to be raised to keep the material moving. The transportation of 4000 tons on an average haul of 8 mi. for 75c. per ton was the cheapest hauling. This work was done with teams, and the route was over a new concrete pavement that had an average downgrade of 1½%, though two short hills had to be climbed. A "4-up" team handled a train of five 3-cu.yd. wagons. The teamster used a pinch bar to help the team start the load. The average cost of hauling has been found not to exceed 20c. per ton-mile.

San Bernardino County was fortunate in having three exceptional men to look after the general details of the work: J. B. Gill, former Lieutenant-Governor of the State of Illinois, was chairman of the commission; George Hinckley, an able engineer and city manager of Redlands, Calif., represented that community on the commission; and W. A. Freemire, a banker, the third member, represented the western portion of the county. The author was chief engineer and had active charge of all the operations of the commission. The members of the commission were subject to many annoying details in allowing claims, from which they would have been free if the contract system had been adopted.

Sinking Concrete Cylinders Under a Philippine Bridge

The road and bridge system of Tayabas Province, P. I., was badly damaged by a typhoon a little over a year ago, and has since been returned nearly to normal. The reconstruction of the Dumacaa bridge—one of the larger structures wrecked—has several noteworthy features, which are described by A. T. Sylvester, district engineer, in the *Quarterly Bulletin* of the Bureau of Public Works.

The main span of the Dumacaa bridge is a 100-ft. steel through bowstring truss. There is also a 20-ft. reinforced-concrete span. The floor surface is concrete. The east abutment was on rock and was undisturbed, but the pier and west abutment, founded on sand and gravel, were undermined.

The reconstruction plans called for a new pier and a new abutment—each carried on two concrete cylinders. The original superstructure was put back in place, but 26 ft. west of its former position, on the old center-line, and about 6 ft. higher than the old elevation. The east abutment was carried up to the required height.

Two sets of forms were made for the reinforced-concrete cylinders—which were precast—one 13 ft. long and the other 10 ft., 2x4- and 2x6-in. lauam lumber being used. The outside form had a batter of 1:120 to reduce friction, which necessitated splitting all the staves. The outside form was built in two pieces, the inside one in four to facilitate removal. The cutting edge, shod with a small angle iron, had an inside bevel of 60° from the edge of the angle to the full 8-in. thickness of the cylinder. First, the inside form was erected, then the reinforcing steel and the outside form, following which the concrete was poured.

The cylinders were allowed to set for 21 days, being kept thoroughly wet down during that period. A longer time could not be allowed, owing to the necessity for getting the work done before flood time. The two pier cylinders were rolled into the river and dragged into position by a hoisting engine, being spotted by two 5-ton hand differential hoists. Rock was encountered at once, and the entire excavation in these cylinders was in rock, which was loosened by chisels, loaded by divers (with helmet only) into buckets and hoisted out. There were two of these buckets, made by the blacksmith, of sheet iron having wooden bottoms. Each held about 2 cu.ft.

Excavation in the abutment cylinders was easier. Two divers—using a half of a cocoanut shell and their hands—were able to load 11 buckets of sand per shift.

The average rate of sinking, including the necessary building up, was 1 ft. per day. For building up the cylinders as they were sunk, one set of original forms was cut in half to reduce weight, and four holes were left near the top of the section last cast. In these holes ¾-in. bolts were inserted to support the forms, no guide piles or falsework being used.

The abutment cylinders were sunk 19½ ft. below low water and were filled with concrete. Two or three days later the pier cylinders reached their final depth of 15 ft. In each instance a seal of concrete was first run into the bottom of the cylinder with a tremie made of a piece of 6-in. galvanized iron pipe, handled by block-and-tackle. A diver leveled off the concrete thus deposited, and 24 hours later the cylinder was unwatered and the remaining concrete was placed in the dry.

Canal Zone Water-Purification Plants Meet Tropical Conditions

Information on the treatment of water-supplies in tropical countries is so scanty as to make of great interest the large amount of detailed information on the three water-purification plants in the Canal Zone contained in the annual report of the Governor of the Panama Canal for the fiscal year ended June 30, 1916. The 66 closely printed pages on this subject were prepared by George C. Bunker, physiologist, and form a portion of the report of D. E. Wright, municipal engineer. Some leading facts from Mr. Bunker's extended discussion of the water-purification plants and their operation are given in the following paragraphs.[1]

All three of these water-purification plants employ mechanical filtration, and the two larger ones use chlorination in addition.

The Agua Clara plant, supplying Gatun (population about 1900) was put in operation Dec. 29, 1911. During the year covered by the report it treated an average of 693,300 gallons.

The low alkalinity, 14 to 20 parts per million, of the raw water-supply of this plant—derived from an impounding reservoir—and the amount of alum necessary for the removal of the color, which varied from 30 to 110 parts per million during the year, produced conditions such that it was considered not only advisable, but obligatory, to increase the alkalinity and decrease the free carbonic acid in the filtered water by the addition of lime.

The effect of filtered water with varying free carbonic acid and alkalinity contents on galvanized-iron pipe conveying filtered water to the laboratory of the Agua Clara plant is shown in the two tables given in the report. It appears, says the report, "that comparatively large amounts of iron are taken up by this water while standing in the pipe for 14 hours."

The Mt. Hope purification plant was put in operation Feb. 23, 1914. During the year it treated an average of 4,156,700 gal. for the supply of a population of 37,000 located in Colon, Cristobal, Mt. Hope and Margarita Point, at the northern end of the zone.

A feature of the Mt. Hope plant is an aëration basin 60x66 ft. in plan, equipped with 85 cone nozzles, arranged in five batteries of 17 each. Quoting from the report:

> The nozzles are so adjusted that, under ordinary operating conditions, the raw water is discharged at an angle of 30° in a thin sheet which breaks up into fine drops. The average diameter of the circle which would be formed by the discharge of one nozzle striking the floor would be 24 ft. The average loss of head due to the nozzle itself is 1.95 ft.

A typical illustration of the effect of aëration through the nozzles adjusted as just described shows dissolved oxygen increased from 5.09 to 7.38 parts per million and in percentage of saturation from 65.2 to 93.1. The corresponding carbon dioxide was 2.5 parts per million for the raw water and 0 for the aërated water. Detailed figures for the effect of aëration at the Mt. Hope plant are given in the report and likewise for the results obtained at the Miraflores purification plant by aëration through 105 cone nozzles discharging water at an angle of 20° as contrasted with 30° in the case of the nozzles at the Mt. Hope plant.

The Miraflores purification plant has been in operation since Mar. 14, 1915. On the average it treated 8,180,000 gal. per day during the year for the supply of 75,000 people in Paraiso, Pedro Miguel, Corozal, Balboa, Balboa Heights, Ancon, Fort Grant and the City of Panama, with a combined population of about 75,000.

During the first 15 months of operation it was found unnecessary to make any repairs or changes to the underdrainage systems of the filters (designed by George M. Wells), which consist of concrete false bottoms 1 ft. thick over pressure chambers 2 ft. deep. In the false bottom there are vertical ⅜-in. feed pipes, spaced 6 in. c. to c. Above the floor the ends of the pipes are bent 180°, so that the wash water is deflected downward. Pressure chambers of filters equipped with and without strainers were examined, and it was found that no sand had passed down through the feed pipes. Mr. Bunker is of the opinion that strainers are unnecessary with underdrainage systems of this type.

Sterilization of the filtered water was continuous throughout the year, hypochlorite of lime having been obtained from the United States in 100-lb. drums and stored in a dry room prior to use. From 0.55 to 0.83 part per million available chlorine was applied.

Twenty days after the disinfection was begun at this plant the discharge pipe from the hypochlorite-solution pump was so badly coated with calcium carbonate as to prevent delivery at the normal volume of solution. During the year it was necessary to clean the pumps and discharge lines about every 10 days, the pumps being in duplicate.

On account of the rapid accumulation of scale in the small centrifugal pumps and their discharge lines and the increased cost of bleach it was decided to substitute one of Wallace & Tiernan's automatic chlorinators, but it was not received until after the close of the fiscal year.

The various water-supplies are from impounding reservoirs, four of these with discharge capacities ranging from 280,000,000 to 650,000,000 gal. when full. The watersheds are uninhabited.

Unusual precautions are taken to prevent contamination by maintenance gangs in the drainage area of the water-supply. These gangs are provided with buckets in which all their dejecta are placed. The buckets are brought in at the close of the day and their contents buried or emptied in vaults outside the drainage areas.

Many wild animals roam over the water-supply catchment areas. Of one of these the report contains the following interesting statement:

> The one animal which probably adds the largest amount of fecal matter to the water is the tapir, which deposits its excreta directly into the water. During the dry season it hunts out the small streams or feeders which, while nearly dry, have small pools of water into which the animal, weighing from 700 to 1000 lb., continues to defecate from time to time, until a pool is filled up, after which it moves to another. The droppings resemble those of the horse. At the end of the dry season there is a large amount of tapir manure in the beds of all the creeks or feeders, which is carried into the reservoirs by the first hard rain of the wet season.

The members of the staff of the Physiologist, George B. Bunker, are: Edward J. Tucker, chief assistant and superintendent of the Miraflores plant; Harry T. Campion and Theodore R. Kendall, superintendents of the Mt. Hope and Agua Clara plants; Hugo F. Schmidt, chemist; and Harold W. Nightingale, biologist.

[1] Those who wish full details will find them in Appendix A, Report of Engineer of Maintenance, Municipal Division, pp. 120-184, Annual Report, Governor of the Panama Canal, Balboa Heights, Canal Zone.

Sector Gates at Middle Falls Dam on Genesee River at Rochester

SYNOPSIS—Description of the movable sector gates on the new hydro-electric development of the Rochester Railway and Light Co., at Rochester, N. Y.

As a part of the new hydro-electric development on the Genesee River at Rochester, N. Y., described in *Engineering News*, Nov. 2, 1916, p. 821, the Rochester Railway and Light Co. is installing as a part of the movable dam at Middle Falls two sector gates, each 100 ft. long. These gates are described by E. R. Crofts, designing engineer of the company, in the January issue of the company's organ, *Gas and Electric News*. From that article the following description has been abstracted, but the originals of the views and drawings have been furnished by Mr. Crofts.

The two gates are identically alike and are separated by large concrete piers, so that each gate is a complete working unit. The movable portion is in the form of a 44° sector of a cylinder 60 ft. in diameter and is built up of steel framework, as shown in Fig. 1. In all there are 13 trusses equally spaced. One radius of this sector is covered by what is called a deck plate, and the front or curved portion is covered by a face plate. The whole structure is hinged at what would be the center of the cylinder, thus allowing the gate to move up and down through the required arc. Angle-irons have been placed on the deck plate to act as skids for the ice and débris passing over the dam. The front and deck plates are ½ in. thick and are made water-tight by calking at the joints.

The whole structure was designed strong enough to support the weight of a 14-ft. depth of water passing over the dam when the gate is in the down position with no water in the chamber underneath to act as a counterbalance or support. Great care has been taken to have

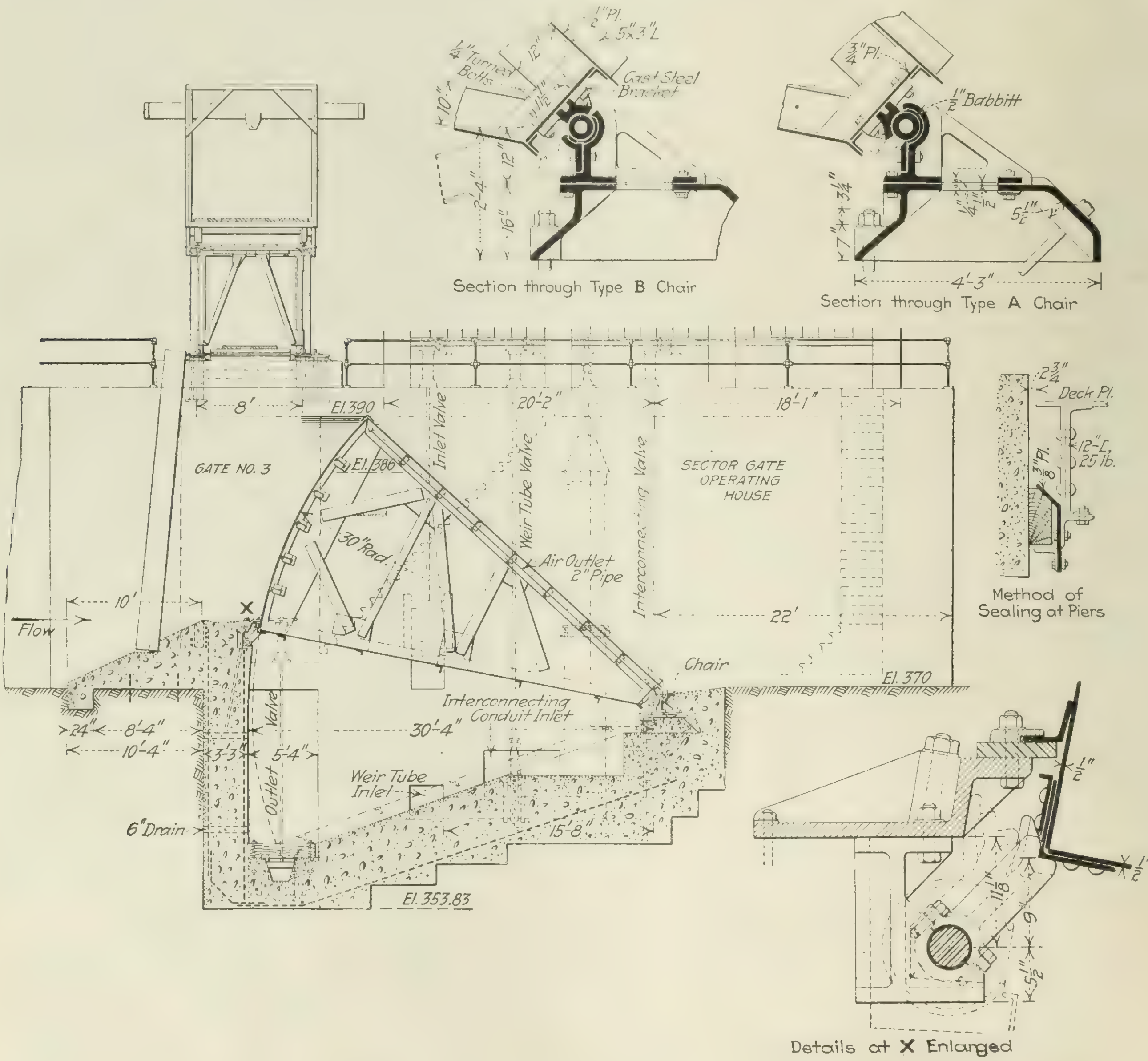


FIG. 1. DETAILS OF 100-FT. LONG SECTOR GATE AT MIDDLE DAM, GENESEE RIVER, ROCHESTER, N. Y.

the front plate a true cylindrical surface, and to this end the whole structure was assembled in the shop and carefully fitted prior to shipment.

The gates are raised and lowered by varying the height of the water in the chamber under the dam. Water is admitted to the chamber beneath the gate from an intake located as far upstream as it was practicable to place it, in order to obtain a maximum head. When the gate is in the down position, there is a difference of elevation of 6½ ft. between its peak in front and the top of the deck plate at the hinge. This head of water will cause an upward pressure on the deck plate sufficient to lift the gate very slightly off the sills at the bottom of the chamber and, if the water in the pond is held at the same elevation, place the gate in equilibrium. In this position two forces are acting on the gate—namely, the weight of the structure, and the upward pressure of the water. As the gate rises, the center of gravity of the gate moves through an arc, so that its horizontal distance from the center of the hinge steadily decreases.

If, therefore, the water in the pond is allowed to rise with the peak of the sector, the gate will continue to lift to its up position, due to the steadily decreasing moment of the weight of the structure about the hinge and the increasing pressure of the water on the under side of the deck plate. It would be possible, therefore, to raise the gate with a full flood passing over it, if it were necessary to do so. In order to adjust the height of the gate, it is necessary to adjust the elevation of the water under the gate; that is, if the gate is to be held in a certain position, it is necessary to keep the elevation of the water inside constant. This is done by means of a special valve called a weir tube, a detailed description of which appears later in this article.

The water used in operating the gate passes first through a coarse screen at the entrance and then through a fine screen placed in a separate chamber. Behind this fine screen are two 30x30-in. sluice gates, each of which controls the flow to a gate, through which the water passes to a large settling chamber where it is hoped most of the silt will be deposited. Another 30x30-in. sluice gate controls the flow from this chamber to the chamber of the dam. In order to remove the accumulated silt a 24x24-in. sluice gate was installed at the lower end of the chamber to allow sluicing of the silt deposits into the tunnel below. In order to catch any silt deposits that may pass through the settling chamber and also to insure complete drainage of the chamber when necessary, a small ditch was placed in the bottom of each chamber. The water from the gate chamber is drained off through a 24x24-in. sluice gate out into a small tunnel placed exactly on the center line of the operating pier. The overflow from the weir tube is also carried off through this tunnel.

Design of the Gate Hinge

It is absolutely necessary that free air conditions exist in the peak of the dam; to insure this, twenty-four 2-in. air pipes have been carried into the peak space from the space from behind the hinge. As the water rushes over the gate during flood period, it will evidently tend to suck the air out through these pipes from within the dam, thus creating a partial vacuum and putting an excessive load on the structure. In order to prevent this condition large pipes have been installed to connect the space back of the hinge directly with the outside air.

The hinge is 100 ft. long and continuous. Several ideas were developed, but the one shown in detail in Fig. 1 seemed to adapt itself best to the work required. The shaft is made of cast steel 6 in. in diameter, and is hollow in order that a steam pipe may be run through the shaft and returned inside the dam, so that the formation of ice near the hinge can be prevented. Should a large amount of ice collect close to the hinge, it is evident that the nut-cracker action would be fatal to some part of the structure.

It was essential that the shaft should turn with the moving parts, in order that an indicating device could be put on the end in the operating house so that the operator might know the exact position of the dam at any time during the flood period. The thrust of the gate is carried to a heavy girder of structural steel, well braced to the deck plate and to the lower lateral system of the trusses. To this girder, located 6 in. away from the center line of the sector, cast-steel shaft brackets have been fastened. The 6-in. cast-steel hollow shaft was bolted to these shaft brackets by means of tap bolts, and the brackets were in turn fastened to the structural-steel girder by means of 1¼-in. turned bolts.

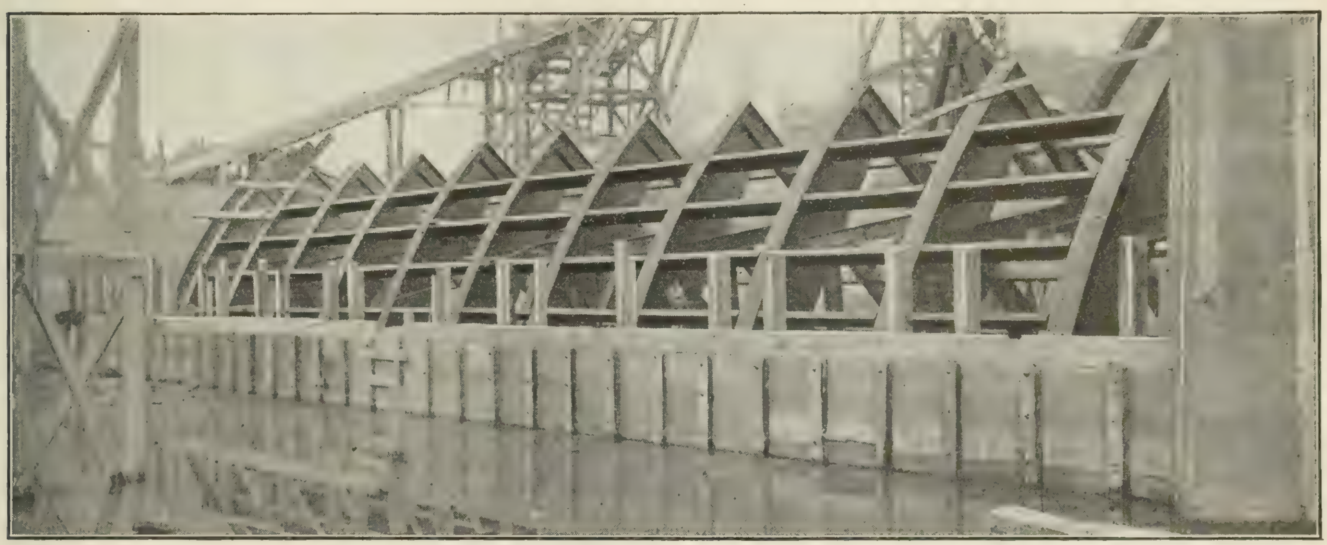


FIG. 2. VIEW OF FRONT OF GATE UNDER CONSTRUCTION

The greatest stress that comes on the hinge is not the thrust from the water in the pond, but the lifting force due to the water under the deck. This will also explain why the castings carrying the shaft were built in the form of a hook. It was impracticable to design shaft brackets that would make the lines continuous, so two types of bearings were designed—one called Type A and the other Type B, the former taking practically all the "uplift," assisted when the dam nears the up position by Type B, which has fastened to it the cast-steel keeper that takes all the downward reaction when the floods are passing over the gate.

The cast-steel bearings are all bolted to heavy cast-iron bed plates, which in turn are anchored with heavy bolts into the concrete. The anchor bolts do not grip sufficient concrete to withstand the uplift, so a heavy reinforcement was put in the entire floor of the chamber to tie together the whole mass of concrete contained in the chamber.

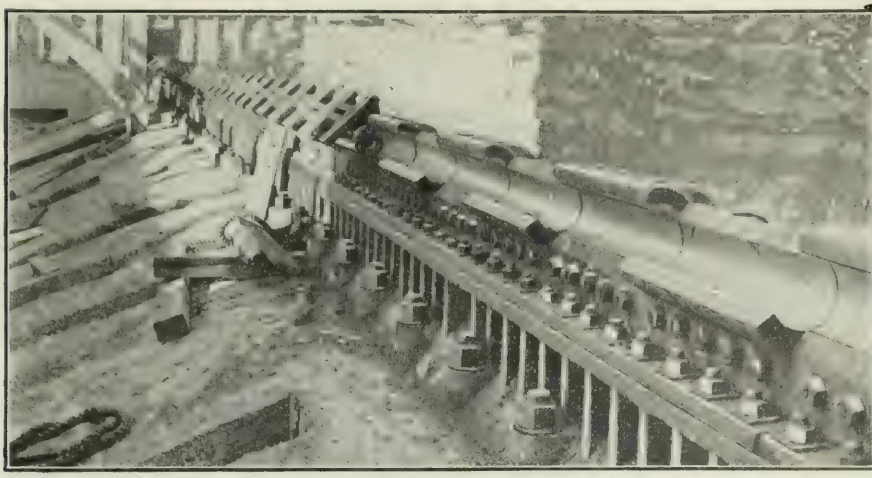
The hinge was designed so that a perfect alignment of all the parts could be obtained in the field as easily as possible. For this purpose the tops of the cast-iron bed plates were machined, and the bolt holes were carefully checked after the bed plates were lined up in position. The cast-steel bearings were carefully machined to the same jig, and all were babbitted with a mandrel in exactly the same position, so that the center line of the shaft had to be exactly the same distance above the bottom of the casting at every point. Each keeper was placed on its respective casting, babbitted in that position and shipped to the field bolted to its particular chair. The tendency for these bearings to shift downstream was taken care of by the lugs on the cast-iron bed plates, which proved to be a very handy place for the fieldmen to work from in the erection of the hinge. A high-grade babbitt was chosen for the bearings, because the pressures will run fairly high.

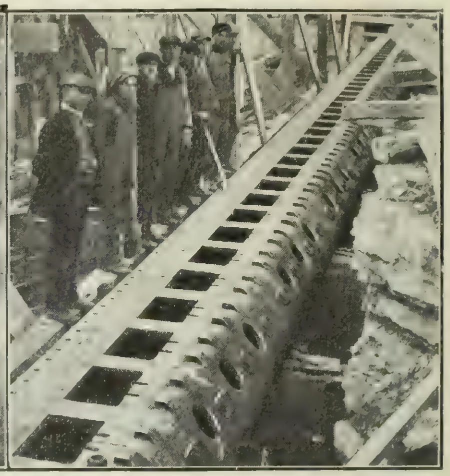
A very low unit stress was used both in the iron and the steel castings. This was done, not because it was considered impracticable to get good castings, but because of the fact that the gate might be subject to a shock of undeterminable amount, such as that from a large tree coming down the river or a large field of ice suddenly loosened; and all the shocks received by the structural-steel work must be taken care of by the hinge. A very good grade of steel castings was secured for this work; the steel is very ductile, and there appears to be no danger of wrecking the hinge by a sudden shock.

Weir Tubes Control Gate Weight

The weir tube is a special valve for controlling the level of the water in the chamber under the gate. It consists simply of a cast-iron pipe 36 in. in diameter, set in a pit in the operating pier. At the top of this pipe is a stuffing box through which a 30-in. pipe, turned on the outside, slides. At the top of this 30-in. pipe is a heavy cast-iron outfall to which a 4-in. shaft for raising or lowering the tube is fastened. Cables, which pass over sheaves to a concrete counterweight in a separate chamber, also fasten to this head casting. The 4-in. shaft connected to the head casting passes up through a floor stand placed on the floor of the operating house and is threaded for a length of 10 ft., that being the range of movement of the tube.

The floor stand is motor operated, so that the tube may be controlled from a distance if desired. Each gate has its own tube, and should either tube become jammed or damaged, it may be segregated by closing a 30-in. gate valve interposed between it and the dam chamber. One conduit in which there is a 24-in. gate valve connects both chambers; and when one tube is out of commission, the valve may be opened and both gates may be controlled by one tube, if it is so desired.





FIGS. 3 AND 4. HINGE TO SECTION GATE ON GENESEE RIVER DAM

Fig. 3 (Left)—Shows hinge partly assembled, looking toward operating pier. Note shaft brackets attached to hollow shaft ready to receive structural work. Hook castings are Type A, low castings are Type B. Fig. 4 (Right)—Shows cast-iron bed plates ready to receive the cast-steel bearings

The hinge for one sector dam contains 25 tons of iron castings, 30 tons of steel castings, 2500 lb. of high-grade babbitt metal and about $1\frac{1}{2}$ tons of $1\frac{1}{4}$-in. diameter bolts. The hinge was furnished by the Ricker Manufacturing Co., of Rochester, N. Y. The structural steel of each gate weighs 150 tons and was furnished by the Chicago Bridge and Iron Works, Chicago, Ill. There are about 18,000 field rivets to be driven in each gate. The breast wall plates, prop and prop shaft for one gate weigh 45 tons and were furnished by Jackson & Church Co., of Saginaw, Mich.

The project has been carried on under the supervision of the Engineering Department of the Rochester Railway and Light Co. J. T. Hutchings is General Manager, and F. J. Howes is Chief Engineer, with Mr. Crofts in charge of the work at the dam. N. H. Guinter was resident engineer for the whole project. The Dock Contractor Co., of Hoboken, N. J., is the contractor.

Engineers' Fees in Iowa

A schedule of minimum charges for engineering services was recently adopted by the Iowa Engineering Society, the substance being as below:

Engineers as a rule now base their charges upon one of the three following methods: A per diem rate; a fixed sum; or a percentage of the cost of the work. In the following proposed schedule, based upon the above methods, current practice has been combined with ideas put forward by members of similar state organizations in an effort to supply a basis upon which fees for the professional services of the engineer may be standardized at some future time.

PER DIEM RATE—(1) Consultations, opinions, expert testimony, preliminary investigations and preliminary reports, \$25 per day. (2) In a consulting capacity on design or for services covering a greater period than one day, \$25 per day. (3) For examinations or reports of a more extensive nature, \$15 per day.

While absent from home city, or attending court or similar duties or traveling, each day of 24 hr. or fraction thereof shall be considered as one day, irrespective of the actual time spent on the case. Otherwise, seven hours shall constitute one day. An additional charge shall be made to cover actual expense and expense of assistants.

FIXED SUM—(1) A fixed sum covering all services and expenses may be charged. (2) A fixed sum covering services only may be charged, and additional charge made to cover expenses both personal and for assistants. A fixed sum may be charged for any well-defined portion of work on a project, and the balance may be charged per diem or by percentage of the cost of the proposed work.

PERCENTAGE OF COST—(1) For services of a preliminary nature, estimates, reports, etc., 1½% of the cost. This can be handled on a per diem basis or on a fixed-sum basis. (2) For the above services and in addition the preparation of the drawings, specifications and contract, and all work to the letting of the contract, 2½% of the cost. (3) For services included in (2) and handling the letting of the contract and consulting supervision of the work, 5%. (4) For services included in (3) and full responsibility for the inspection and construction, including all engineering, 6% of the cost.

In making a contract for services, either on the percentage plan or the fixed sum, a time limit should be set, and the engineer should fix a proportional additional charge for extension of time of completion in case it is in no way his fault.

In Iowa a large number of engineers are engaged in both drainage and municipal-improvement work. The charges for the former do not cover private drainage work, but only drainage-district work where the cost reaches \$20,000. Consultation and expert testimony, minimum charge per day, \$25 and expenses. Field engineer, minimum charge per day, \$10, adding cost of help and all expense. Municipal engineering is best handled on a percentage basis in most cases, and the minimum fees suggested are: 6% for water-works and lighting plants, 5% for paving and 7% for sewers. Both of the two latter are exclusive of inspection fees, but include assessment plat and schedule.

Curved Concrete Abutment Patented

Under date of Sept. 26, 1916, the United States Patent Office granted a patent to Milton T. Thompson, of Keokuk, Iowa, on a curved reinforced-concrete abutment designed according to the drawings shown in the accompanying facsimile of the patent and specification drawings. The wall, it will be noticed, is in plan a semicircle with extending tangential legs. It is built of concrete reinforced with circumferential rods, spaced and arranged vertically to accord with the sloping sides of the abutment, as shown in Fig. 3 of the specification.

The principle of the wall, according to the specifications, is that buried rear wings are held by friction sufficient to create a tangential reaction at the end of the wall. The thrust of the earth back of the wall is transmitted from the earth radially to the wall and

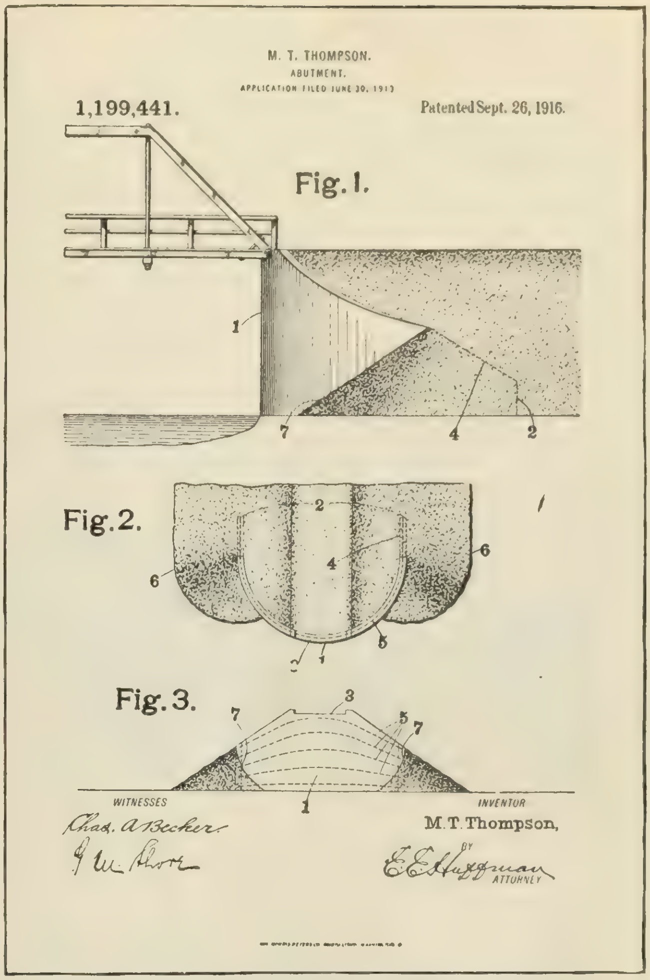


FIG. 1. FACSIMILE OF PATENT SPECIFICATION DRAWING ON THE CURVED ABUTMENT WALL

thence circumferentially back to this frictional reaction. It is claimed that with this principle the wall can be designed much lighter than for any other type of wall.

Several such walls have been built in connection with the roadwork around the Keokuk dam across the Mississippi River. One of these is shown in Fig. 2. The

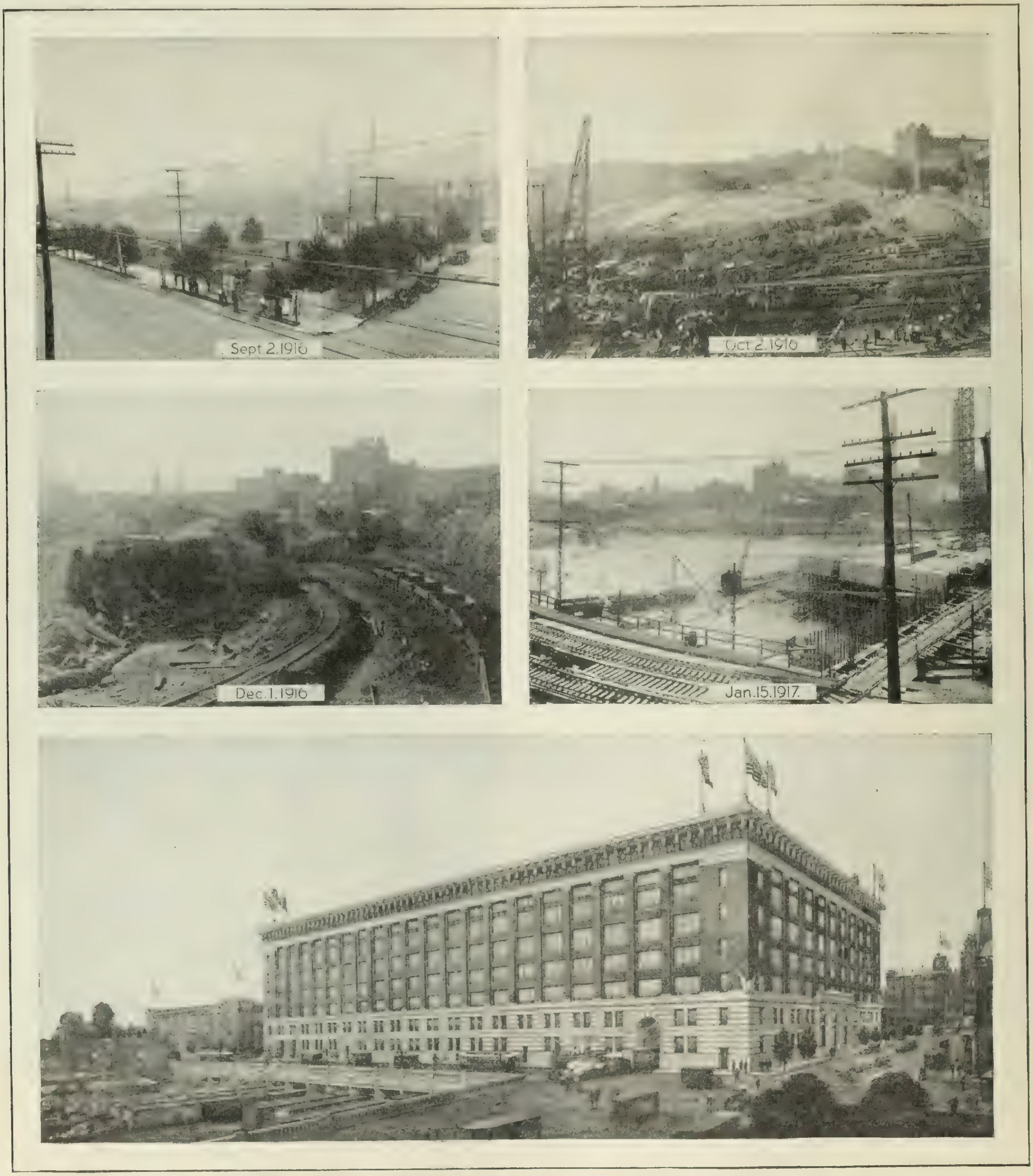
FIG. 2. CURVED ABUTMENT FOR BRIDGE NEAR KEOKUK

abutment is 28 ft. high above the foundation and has a uniform thickness of 15 in. from top to bottom.

The rights to use the patent are controlled by the Thompson Abutment Sales Co., 120 W. 32nd St., New York City.

Quarter Million Yard Excavation Made for One St. Louis Building

The growing prohibition wave has reacted in at least one instance to the benefit of engineers and contractors. In St. Louis the Anheuser-Busch Brewing Association has now under construction a $4,000,000 plant for the brewing of its new non-alcoholic beer, known as Bevo. This product was put on the market only about six months ago and so soon proved successful that the advertising campaign had to be curtailed, pending the construction of a new plant, which was immediately ordered by the Association when it was found that the beverage would prove so popular. Every effort is being made to put the new plant into early service.



FIGS. 1 TO 5. PROGRESS VIEWS OF EXCAVATION FOR BEVO BUILDING AT ST. LOUIS AND (BELOW) ARCHITECT'S PERSPECTIVE OF BUILDING

The site for the new structure was selected just east of the large area now occupied by the brewing plant, and plans were immediately made for the construction of a reinforced-concrete building 252 x 600 ft. in plan and eight stories above ground in height.

This plan is shown in the architect's perspective in Fig. 5. It occupies a whole city block on a site which had been up to that time used as the entrance for the street-railway tracks approaching the main brewing plant. The new construction required the excavation of the site to a maximum depth of 30 ft., the transfer of the railroad tracks to a yard nearer the river, which is only a few blocks east of the site, the reduction in grade of the blocks east of the site to permit the entrance of trains under a viaduct carrying the street in front of the plant. The whole excavation, the construction of the viaduct (which will become city property) and the construction of the plant were not started until late last fall. Fig. 1 shows the site on Sept. 2. The succeeding views show the very rapid progress made in the excavation, which, when completed, will total 250,000 cu.yd.

FIG. 6. CARS DUMPING TO MAKE FILL ALONGSIDE MISSISSIPPI RIVER

At first bids were considered for the excavation, but it was afterward decided to do the work under the direction of the Manufacturers R.R., a terminal railroad controlled by the Anheuser-Busch company. This organization, under the direction of William Cotter, President, and R. P. Dalton, Superintendent, carried out within four months practically the whole of this quarter-million yard excavation by means of large and small steam shovels, dumping into large-capacity dump-cars that traveled on the main-line tracks of the Manufacturers R.R. to a dump on the near-by river front, where a new terminal yard was made with the fill (Fig. 6).

During the excavation the street in front of the building which in the future will be on a reinforced-concrete viaduct, is carried on a timber temporary structure, a part of which is shown in the foreground of the view taken Jan. 15, 1917. On this temporary structure run street car tracks, a highway and sidewalks. Underneath it the earth excavation trains pass to and from the site and the tracks carrying material trains for the building construction are located.

At one time four steam shovels, one clamshell working on a derrick and one locomotive crane were in operation on the site. The progress pictures show the method in which the excavation was made. Two steam shovels, one a 70-ton Marion and one a 70-ton Bucyrus, were in operation practically all the time; and two smaller shovels, one a 14-B Bucyrus and one an 18-B Bucyrus, were used in the corner work, where the smaller shovels could not reach. With this equipment very high yardage records were made. The excavation for the most part was in earth, although there was some rock as grade was reached. All the excavation, however, was made with the steam shovel. In one 10-hr. day 5700 cu.yd. was dug with the two large shovels, which were equipped with 5-yd. buckets. The loading was made on trains of 12- and 15-yd., Western Wheel Scraper Co., steel cars, which had been brought up from the Panama Canal, where they had been in service during practically all the construction. They were found to be in remarkably good condition and served admirably for the purpose.

The total cost of the work has been very low, considering the speed with which it has been done and the nature of the work. Bids ranged as high as 80c. to $1 a cubic yard for excavation, but with about 5000 yd. yet to go, it has been found that the average cost per cubic yard will be about 45c. Fig. 4, taken on Jan. 15, shows the excavation practically completed and the north end of the reinforced-concrete building under construction. This building is to be very heavy, having a live-loading of 250 lb. per sq.ft. on all floors. It is of beam and girder reinforced-concrete construction, to be built in sections 252 ft. long and about 125 ft. wide, divided by expansion joints through all the stories.

California Greatest Manganese Ore Producer in 1916—For the first time in the history of manganese mining in the United States, a Western state, removed from the steel-producing centers, took the lead in 1916 in the production of manganese ore. According to a preliminary estimate of the United States Geological Survey the biggest producers were California, Arkansas, Arizona, Georgia, Virginia, Utah and Colorado, the aggregate output being 27,000 tons—the greatest since 1888 and nearly three times that in 1915. The estimate does not include manganiferous ores that contain less than 40% manganese. Imports of manganese ore for the first 10 months of 1916 amounted to 495,299 tons, of which 401,177 tons came from Brazil.

Congress Is Nearly 0.5% Engineer—The desirability of the engineer's participation in public affairs has been urged repeatedly, until there is danger of its becoming a monotonous refrain. The concrete result of this agitation—so far as the national legislature is concerned—appears to be a grand total of two engineer Congressmen. The New York "Evening Mail" recently made a professional inventory of the members of Congress, with the following results:

Of our 96 United States Senators the classification is as follows: Lawyers, 53; farmers, 5; editor, 1; cotton planter, 1; planters, 2; stock raiser, 1; bankers, 2; literature, 1; journalists, 4; public officials, 22; physician, 1; irrigationist, 1; lumberman, 1; manufacturer, 1.

Of our 440 Representatives there are these classifications: Lawyers, 240; public officials, 79; bankers, 15; editors, 6; physicians, 2; farmers, 19; manufacturers, 11; merchants, 3; real estate, 10; lumber, 3; publishers, 10; stock raisers, 2; journalists, 3; steamboat, 1; towing, 1; contractors, 3; cattle, 1; agriculturist, 1; iron molder, 1; insurance, 1; engineers, 2; director, 1; landholder, 1; hotel, 2; educators, 5; ranchmen, 4; city assessor, 1; nurserymen, 1; coal miners, 2; chemist, 1; wool merchant, 1; writer, 1; cotton, 1; ruggist, 1; railroad official, 1; mercantile, 1; telegrapher, 1; capitalist, 1.

If the list quoted is accurate—and the two engineers are not of locomotive or stationary class—the engineer faction is not likely to exert vast influence in placing laws on the national statute book. The lawyer has always been dominant in politics. In the present Congress he is, numerically, 55% of the Senate and 55% of the House. The engineer is not quite 0.5% of the total—a humiliating condition. Much the same condition obtains in the House of Commons. The London "Times" contends that the present elective system is misrepresentative, and it favors election by occupations, industries, trades, rather than by geographical divisions or community

Bucking the Big Drifts in Wyoming

By J. Cecil Alter*

SYNOPSIS—Fighting the greatest snow drifts on record on the Union Pacific R.R.

No less than 40 transcontinental passenger trains were snowbound and idle in Wyoming between Laramie and Rawlins at one time during the snow blockade of January-February, 1917. The Union Pacific System, concentrating its attention on the 46 miles of line between the Lookout and Hanna stations, waged what is considered to be the most important fight in its history against wind and snow—a battle that did not cease night or day for two weeks.

From Jan. 22 until Feb. 4, the double- and triple-track roadway was sealed in by deep, hard snow for the first time in history. When the army of snow-fighters "holed through" for the last time, the wind blew a practically continuous gale from the west, filling the cuts with snow sometimes within half an hour after opening them by the rotary snowplows. Within this period trains were forced through the blockaded region with the greatest difficulty, and delays of from 6 to 36 hours were common. Freight movement was entirely suspended; and from Jan. 25 to 27 and from Feb. 1 to 3, when the wind seemed at its height, no trains penetrated entirely through the blockade.

Beginning, however, on the night of Feb. 4, the wind subsided and trains began to move. In this movement new records for train handling are said to have been established. There was a congestion of between 40 and 45 passenger trains, many of which were stalled between stations. Practically all had to be dug out by the work of approximately a thousand laborers with picks and shovels. The tracks were entirely cleared in both directions in the 24 hours of Feb. 5. Then followed the movement of freight, which, until date (Feb. 18), has been flowing in each direction from the continental divide in streams of from 90 to 95 trains, of from 20 to 25 cars each, per day. Added to these were 16 daily passenger trains and the exchange movement of freight helper engines between Cheyenne and Laramie over Sherman hill. The 10-min. limit between movements has often been approached for many hours at a time in spite of the full use of the double track.

A general snowfall covered the Laramie and Rawlins plains, through which the railroad trends longitudinally, the depth varying on account of the wind from practically nothing to a foot, until Jan. 22. From Jan. 12 to 22, exceptionally cold weather prevailed, temperatures ranging as low at 26° below zero at the Rock River coöperative weather station. The continued cold has the effect of producing minute ice particles of the snow crystals under constant motion from wind agitation.

FIG. 1. ORDINARY STEAM-DRIVEN ROTARY, PUSHED BY THREE LOCOMOTIVES

A fall of 6 in. of snow occurred at Rock River on Jan. 22 in comparatively low temperatures, and with it came the gale. A week later about 2½ in. more snow fell. No wind record is available in the snowbound region, though the opinion of employees and local residents is that velocities were unusually high and persistent. Substantiating this, to a certain extent, is the wind record at the United States Weather Bureau Office at Cheyenne, which shows the greatest continuous-velocity records since 1871. From Jan. 21 to Feb. 4, 1917, the average daily wind velocities ranged from 14 to 39 miles per hour, and the maximum wind velocities from 41 to 64 miles per hour.

*Cheyenne, Wyo.

MIG. 2. REAR OF SNOWPLOW TRAIN IN SULPHUR LAKE CUT

The contention seems reasonable that the wind blowing across the so-called Great Divide Basin, in south-central Wyoming, is forced through a relatively narrow neck between the Medicine Bow Mountains and a range to the north, and the velocities, under such favorable conditions as just experienced, become abnormally high. In any event this narrowing of the plains causes a definite broadside discharge of wind across the Union Pacific tracks from Lookout to Medicine Bow, where the trend of the line is northwest-southeast.

Only four or five cuts of any great length in this comparatively even-surfaced plain are necessary to maintain the desired grades, and these are broad and shallow as a rule. Two of these, at Lookout and Rock River, have filled at times in the past, notably when the wind and snow were accompanied by intense cold. The two cuts at Sulphur Lake, of a half-mile length, and a 1½ stretch near Wilcox are said never before to have required any important service from the rotaries. These cuts have a more westerly trend, parallel with the prevailing winds.

FIG. 3. JORDAN SPREADER CLEARING SIDINGS AND SWITCHES AT ROCK RIVER

At Lookout a cut about 900 ft. long was opened frequently; at Rock River the entire yard limits of about $\frac{3}{4}$ mile were opened on both tracks with rotaries. Some of the space was opened a number of times. At Wilcox a total of about $1\frac{1}{2}$ miles of cut was filled with snow from 6 to 12 ft. deep, requiring the opening of both eastbound and westbound tracks with the rotaries twice, and in places many more times. The Sulphur Lake cut, near Allen, a half-mile in length, was filled as deep as 20 ft. in places and required drilling with the rotaries four times, with numerous extra trips for cleaning before the storm ceased. In all the deeper cuts extra trips were necessary with the rotaries before the trains could pass over the rails in safety.

FIG. 4. LOOKING NORTH AT ROCK RIVER STATION; NOW UNDER STEEL SNOWSHED

In many of the drifts the depth was greater than the capacity of the rotaries and short holes were drilled, into which the sides and top were broken by laborers—a slow, tedious process. In regions where desert sand was mixed in large proportions with the drifted snow the deposit was so compact that only the huge Jull steam-propelled rotary snow excavator, having a large steel corkscrew projecting from the center of the rotary, could attack it successfully, and then only when three of the largest locomotives available were pushing it against the snow.

Four other steam-driven rotaries were busy every hour for 15 days, a commissary car being attached to the rear for the workmen. In addition there were two Fuller, or wedge, plows built on box cars; two Russell plows, similar to the Fuller plows, but larger; six locomotives having wedge snowplows attached in front; and eight engines equipped with circle flangers, or disks for throwing the snow from the rails only. This was practically all the equipment that could operate in the limited territory affected, though a large-winged Jordan spreader was employed in clearing sidings and switches ahead of the laborers. A steam shovel and dynamite were given a trial, with but little success. The shovel was too slow for work in such high wind velocities, and the explosions were too local and limited in effect to loosen much snow.

Snow fences of the common kind, which in the past have performed effective service, were early drifted under, though from four to seven lines were placed about 75 ft. apart. Subsequently, numerous additional lines of fence were placed on the drifts; but as the wind did not cease, these too were soon under the snow or so much obstructed as to be of little value.

For the future, defense by snow fences is being improved in every possible manner, to deflect and accumulate snow in the most desirable places; and a large part of the main yards at Rock River, about 600 ft. each way from the coal chute where drifting was very heavy, is being covered with a steel snowshed. The inclosure protects the eastbound and westbound tracks and the passing track between. This work is already practically completed.

The damage to track and equipment, aside from wear and tear, was practically negligible, in spite of the frequent deaths of a great many engines stalled out of reach of water or coal. One fatal accident occurred, when, in the blinding snow, a young employee on a private errand stepped from a caboose in front of an approaching train. No other injuries of any kind were reported, and not a

passenger suffered any special hardship or physical inconvenience, as food, heat and bedding were provided just as in ordinary travel, but without expense to any one. Even special entertainment was offered by citizens of Cheyenne, Laramie, Rock River and Rawlins; and for some travelers the joys of jack-rabbit hunting were too abruptly terminated by the clearing of the lines.

Light Timber Auditorium Roof Fails Under Snow Load

By Edwin K. Cortright*

Failure of the lower chord of a 30-ft. roof truss (Fig. 1), due to a heavy snow load during construction, caused the partial collapse of the roof of a wooden temporary meeting shed at Lawrence, Mass. The building, approximately 132 x 240 ft. in plan, has been repaired and will be used as originally intended.

A heavy snowfall combined with snow blown from the roof of a near-by office building caused the initial failure of a roof truss. As no other ties between columns had been provided, the side thrust induced through this failure pushed the remaining portions of the building about 2 ft. out of plumb and allowed the adjoining roof trusses to slip from their bearings. The failure began at the north end of the building and progressed toward the south end, the entire collapse extending over an area 30 x 240 ft. and occupying an appreciable space of time. Had some sort of transverse ties been provided originally between the supporting columns, the failure, in all probability, would have been confined to one or two roof trusses.

As shown in Fig. 2, the original design provided for trusses on 10-ft. centers, half the longitudinal panel length. This truss, with a rise of 4 ft. 8 in., was made up of a 2 x 6-in. upper chord with a butt joint and a 1 x 8-in. lower chord spliced at the middle. Center and inclined 1 x 8-in. posts were used.

Immediately following the failure all snow was cleaned from the roof of the remaining portions of the building and all lumber of value salvaged from the wreckage. The work of pulling the standing portions back into place was then undertaken. The columns were braced transversely near the tops with temporary 6 x 6-in. struts and crossbraced with 2 x 6-in. plank. Wire cables were attached to the 6 x 4-in. posts and the first 6 x 6-in. posts. The center 6 x 6-in. posts were not subjected to any pulling strain. Chain blocks attached with block and tackle to the wire cables were used for the actual pulling. Pulling operations were carried on simultaneously on three adjoining bents, to prevent eccentric stresses. All work of pulling the building back into place was successfully completed in about three days' time.

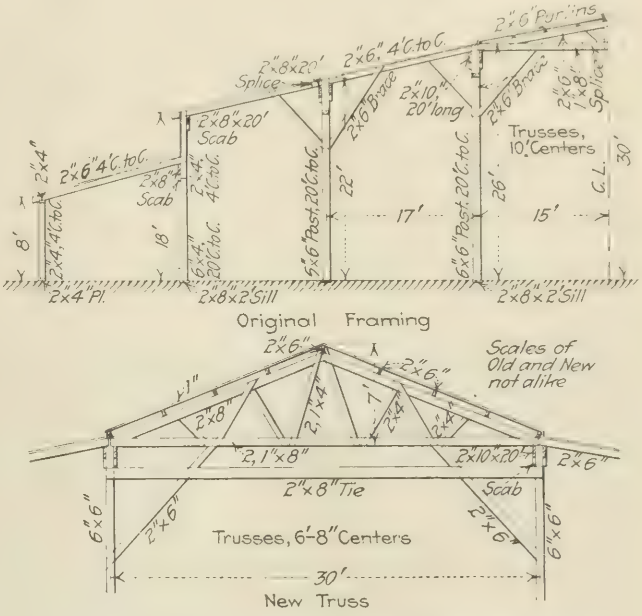


FIG. 2. THE ORIGINAL FRAMING, AND STRONGER TRUSSES USED IN RECONSTRUCTION

New and heavier roof trusses on 6-ft. 8-in. centers, as shown in Fig. 2, have been provided, and a substantial 2 x 8-in. cross-tie has been added as an extra precaution against further accident.

*40 Lawrence St., Lawrence, Mass.

FIG. 1. THIS SHED COLLAPSED BY FAILURE OF THE LIGHT TRUSSES UNDER DRIFTING SNOW

Traffic Census in Shanghai—As an item for the curious, John A. Ely, of St. John's University, Shanghai, China, sends the following results of a traffic census at the corner of Kiengze and Nanking Roads, Shanghai, during the hours 7 a.m. to 7 p.m.; Rickshaws, 20,441; carriages, 1754; motor cars, 1610; street cars, 640; wheelbarrows, 1785; making a total of 26,230 vehicles of various types, and 35,588 pedestrians. Of the vehicles it is interesting to note that 22,226 or 85% were of the one-man power variety—rickshaw and wheelbarrow—which are not very severe on pavements.

Brown Rot in Yellow Pine—Elaborate studies of the physiologic activity of brown rot or "brown punk" in yellow pine were made recently by Sanford M. Zeller at Washington University, St. Louis, Mo. His results have been published recently in pamphlet form by the Missouri Botanical Gardens. The rot is the growth of the fungus "Lenzites saepiaria," which attacks mainly coniferous timber. The brownish or sepia-colored sporophores appear near cracks in the wood due to drying. The fungus is in nature very common on railroad ties, telephone and telegraph poles, etc., but may be found on standing timber. Its growth is strongly promoted by acids (even with 0.25% sulphuric acid it grew luxuriantly) and is inhibited by liquids of alkaline reaction. The growth range of temperature is 5° to 44° C., the best temperature being 35° C. (95° F.). The fungus cannot grow on resin. Experiments made to show how high a resin percentage was required to prevent the growth were made by mixing agar-resin plates. No marked influence of the resin appears until a percentage between 50 and 60 is reached, when there is a sudden reduction of growth, holding up to about 85%, beyond which there is practically no growth. When the fungus was grown on blocks of yellow pine, the influence of resin content of the wood was quite erratic, as is to be reported in detail later. Very full study was made of the enzyme activity or products of the fungus. A large number of enzymes was identified, most of them being highest in the mycelium.

Notes from Field and Office

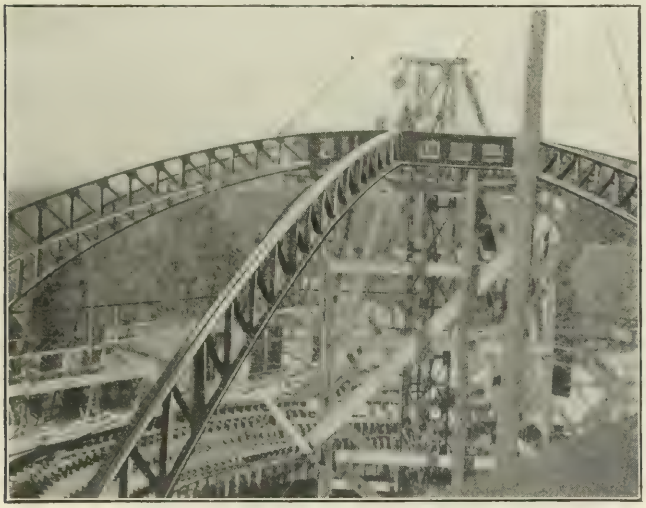
Church dome cost $28 a ton to erect—Plea for commonsense dimensions—Origin and evolution of the steel handbook—Carrying railways over trenches—Plow places signal cable 12 ft. below channel bottom

Method and Cost of Erecting a Large Steel Dome

By M. Van Meter*

The 92-ft. dome of the Wealthy St. Baptist Church, Grand Rapids, Mich., has a steel frame formed by eight main arch members 35 ft. in span, with 19-ft. rise, framing into an octagonal crown diaphragm, 22 ft. wide across the points. The arches are tied together at the heel by four trusses and four sets of angle ties. This is because that portion of the building under the dome is square, and a part of the roof load is carried by the ties in alternate bays.

The arches are 2 ft. deep at the top and 5 ft. at the outer extremity. Three lines of beams parallel to the base ties carry the wooden ceiling and roof joists. The lateral bracing consists of a system of rods together with a line of struts in the center of each bay at right angles to the roof beams. A steel monitor frame 8 ft. high surmounts the structure.



ERECTING ARCHES OF CHURCH DOME

The erection procedure was as follows: A derrick of the required height was raised, and the eight sides of the diaphragm were riveted up around its base. With two sets of blocks, the ring was raised to the final elevation, 45 ft. above the floor, and light timber falsework placed underneath. The arches were raised with a gin pole, bolted in place, and the base ties erected. The roof beams, struts and rods were then placed, rivets driven and supports removed. The entire job was completed without a mishap, the one anxiety being caused by the extraordinarily high winds that prevailed after the diaphragm was raised and before the timber falsework was finished.

The shop cost of this contract was $25 and the erection cost $28 per ton, with labor at 50c. per hour in each case.

*Chief Engineer, Cadillac Machine Co., Cadillac, Mich.

Eliminate Weird Dimensions

By Henry J. Marty*

Charles M. Horton's article, "Drafting Room vs. Shop," in *Engineering News*, Feb. 1, p. 195, expresses sentiments that draftsmen and mechanics will echo.

Detailers and checkers could save some of their fellow draftsmen a modicum of nerve energy by using sane dimensions. Here is a boiler 22 ft. $8\frac{11}{16}$ in. from the foundation to the face of the steam nozzle; why not make it 22 ft. 9 in.? There is no over-all dimension, from the front or back of the boiler to the steam nozzle. Another instance—a large corliss engine, 17 ft. some inches and a few eighths from the centerline of the shaft to the centerline of the throttle. Corliss-engine builders are not the worst offenders; take the little fellows—6 ft. $4\frac{7}{16}$ in. from centerline of shaft to centerline of throttle; $16\frac{3}{16}$ in. from centerline of shaft to centerline of bolt-hole; the other way it is $21\frac{15}{16}$ in. from centerline of cylinder to centerline of bolt-hole—and so on for eight or more bolts.

Look into almost any catalog of power-transmission machinery: A hanger with four bolts is $20\frac{5}{16}$ in. from the center of the shaft to the center of the two bolts on either side, and the latter are $6\frac{3}{8}$ in. apart; why not 20 in. and $6\frac{1}{2}$ in.? On bevel gears the backing from centerline of shaft to the back of the pinion hub may be $19\frac{31}{32}$ in., and to the back of the gear $7^{27}/_{64}$ in.

It probably has not occurred to some of the manufacturers of small steam pumps that their products might be used in a factory where the foundations are installed months before the pump arrives. The carpenter gazes at the blueprint and wonders whether $6^{21}/_{64}$ in. is nearer $\frac{1}{2}$ or $\frac{1}{4}$ in.

On outline diagrams of centrifugal pumps it is sometimes difficult to determine just what is meant. It is desirable to have the distances from the pulley, suction and discharge openings and bolt-holes given, so that no addition or subtraction will be required. Eliminating fractions in this instance might save a dispute.

The fractions have been taken out of flanged pipe fittings, and the burden can be lightened on other work, such as where boilers, engines and thirty or more pump foundations are detailed, for pipe 6 in. and over made up in the shop, shaft-hanger supports made up of structural steel and provided with holes to take the hanger bolts. This machinery may go to the wilderness a thousand miles from where it was made. When it gets there, time is worth more than money.

*1434 Ridgewood Ave., Cleveland, Ohio.

History of Structural-Steel Handbooks

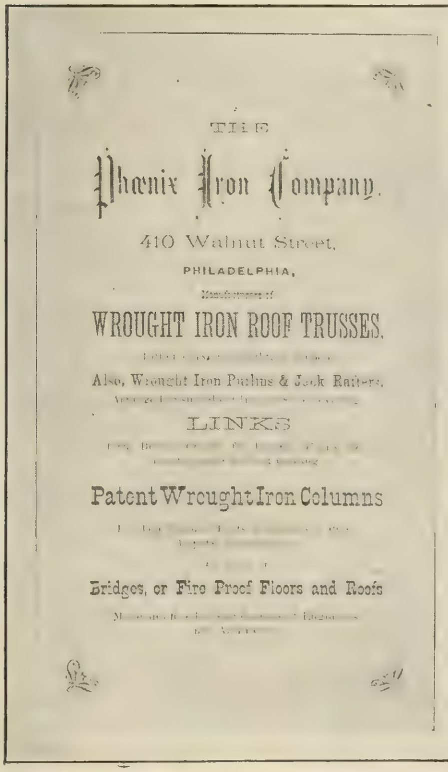
By R. Fleming*

A number of handbooks of unusual interest lie before the writer.[1] The oldest, undated and unpaged, was published by the Phoenix Iron Co. in 1869 and is believed to be the first handbook issued by a manufacturer explaining in detail the use of iron for structural purposes. The book consists of 24 pages 3¼x5 in., 13 of which are taken up with the title, advertisements and lists of the Phoenix products, seven with tables and formulas; four are headed "Memorandum" and left blank. The engineering data are a table of the compressive strength of wrought and cast-iron columns, the Gordon column formula, a formula for the flexural strength of beams, and tables giving the safe loads of I-beams and deckbeams. The products listed are seven diameters of Phoenix columns, eight depths of I-beams, five of deck beams, three of channels, eleven sizes of equal-legged and six of unequal-legged angles, six sizes of T-bars, miscellaneous shapes and round, square and flat bars. The Phoenix Iron Co. issued the first edition of its handbook, "Useful Information for Architects, Engineers and Workers in Wrought Iron," a book of 124 pages 4x6½ in., in 1873 or 1874 (the book is undated).

Another early book, the second in chronological order, is entitled "Rolled Iron Beams Made by the New Jersey Steel and Iron Co."; it is dated 1871 and consists of 22 unnumbered printed pages 3¼x5¼ in. The beams listed comprise nine depths and eighteen weights, ranging from a 4-in. beam of 2.01-sq.in. area to a 15-in. beam of 20.02-sq.in. area. The safe load, deflection, correction for lateral deflection, strength as a strut and moment of inertia are given for each beam; also tables of weights of flat, round and square iron and of bolts and rivets. In 1876 the New Jersey Steel and Iron Co. published an enlarged handbook of 81 pages and three plates. Later editions bore the title "Useful Information for Engineers, Architects and Constructors, and Tables of Rolled Beams, Channels, Angles, etc., made by the New Jersey Steel and Iron Co." Pages and plates were added as warranted.

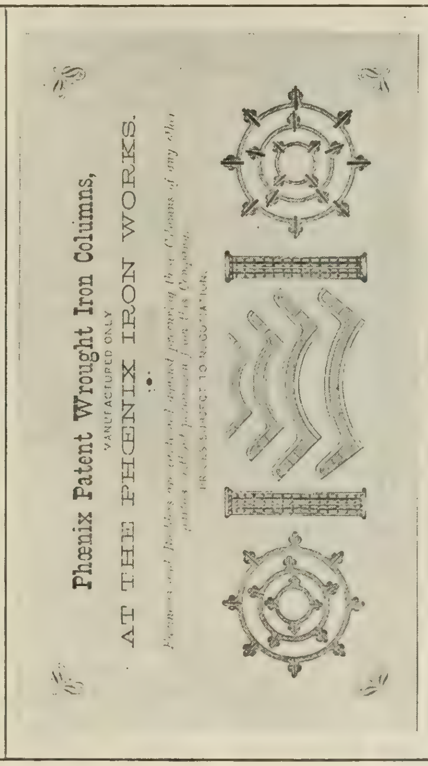
The third book in order of time is the first edition of the widely known "Carnegie." The title page reads "A Pocket Companion of Handy Tables and Information Appertaining to the Use of Wrought Iron, for Engineers, Architects and Builders. Compiled by Walter Katté, Civil Engineer. Presented by Carnegie, Kloman & Co., Proprietors Union Iron Mills, Pittsburgh, Pa." The cover bears the date 1873. The book contains 70 pages, 30 of which are taken up with Carnegie products. The weights, dimensions, properties, safe loads and deflections of beams and channels are fully given. Miscellaneous information and tables complete the rest of the book. Page 14 is headed "Sir Charles Fox's Rules for Proportion of Heads and Pins for Upset Links," and on the next page there is a "Table Showing the Saving in Iron, Effected by the Use of Bolts with Upset Ends."

Another book of interest is the Carnegie Brothers & Co.'s "Pocket Companion," second edition, 1876. The first 30 pages are taken up with the table of contents and lithographs of rolled sections; Part First follows with 60 pages giving "Description and Elements of the Union Iron Mills, Rolled I-Beams, Deck Beams, Channel Bars, Angle Iron, T-Iron, etc., etc., with the Tables of Coefficients When Used as Floor Beams, Rafters, or Struts and



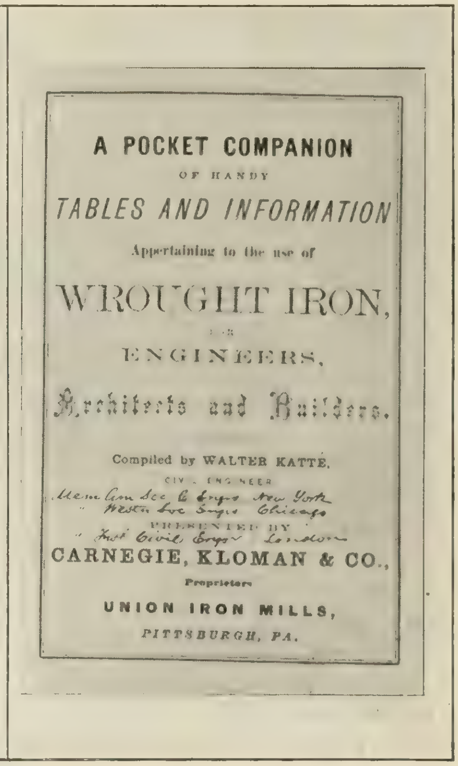
THE
Phœnix Iron Company.
410 Walnut Street,
PHILADELPHIA,
WROUGHT IRON ROOF TRUSSES.
Also, Wrought Iron Purlins & Jack Rafters.
LINKS
Patent Wrought Iron Columns
Bridges, or Fire Proof Floors and Roofs

FIG. 1. THE 1869 POCKET-BOOK WAS A PRICES-CURRENT



Phœnix Patent Wrought Iron Columns,
MANUFACTURED ONLY
AT THE PHŒNIX IRON WORKS.

FIG. 2. ILLUSTRATION FACING TABLE OF PHŒNIX COLUMNS



A POCKET COMPANION
OF HANDY
TABLES AND INFORMATION
Appertaining to the use of
WROUGHT IRON,
FOR
ENGINEERS,
Architects and Builders.
Compiled by WALTER KATTE,
CIVIL ENGINEER
Mem. Am. Soc. C. Engrs. New York
West. Soc. Engrs. Chicago
PRESENTED BY
Inst. Civil Engrs. London
CARNEGIE, KLOMAN & CO.,
Proprietors
UNION IRON MILLS,
PITTSBURGH, PA.

FIG. 3. TITLE-PAGE OF FIRST CARNEGIE—From Mr. Katté's own copy

*American Bridge Co., 30 Church St., New York City.

[1]The writer is indebted to N. R. McLure, Chief Engineer of the Phoenix Iron Co., for the use of early Phoenix handbooks and to R. B. Woodworth, of the Carnegie Steel Co., for information regarding editions of the Carnegie "Pocket Companion."

Pillars"; Part Second fills 80 pages with "Miscellaneous Information for Engineers, Builders and Mechanics." A limited edition of the "Pocket Companion" was printed for distribution at the Centennial Exposition at Philadelphia. It was given mainly to important personages.

The evolution of a handbook is well illustrated in the long line of editions of this "Pocket Companion." No other handbook has been so widely circulated; of the fifteenth edition (1903) over 100,000 copies were distributed. The seventh edition (1892) contained data on both iron and steel, the profile cuts indicating by distinctive colors what sections were rolled in one or both materials. The eighth edition (1893) showed steel sections only and

NOTES FOR ENGINEERS.

BASIS OF STRENGTH.

The co-efficients in the above table, except those in column VII, headed "Maximum Load," correspond to a stress or straining force of 12,000 lbs. per square inch on the part of the beam at which the strain is a maximum. The greatest SHEARING STRESS on the stem under the loads, given in column VII as the maximum allowable, will be 4,000 lbs. per square inch. The ultimate or breaking stress for wrought iron beams, with top and bottom flanges of equal areas, may be taken as the ultimate resistance of the material to compression or from 36,000 to 40,000 lbs. per square inch. Although the ultimate resistance of wrought iron to tension is considerably greater than to compression, the amount of extension or compression, within the limits of strength which can be used in practice, is the same for either force, and therefore wrought iron beams with equal areas for tension and compression have a less deflection, for a given

FIG. 4. PAGE FROM THE TRENTON 1871 BOOK, A PIONEER STRUCTURAL POCKET-BOOK

marks approximately the end of the use of wrought-iron beams and channels.

Passing from these pioneer books to those of the present day—with a tribute to the excellence of the Pencoyd handbook, "Steel in Construction," no longer published—we find the field now covered by the handbooks of the Bethlehem Steel Co., 1911, 120 pages; Cambria Steel Co., 1916, 513 pages; Carnegie Steel Co., 1916, 434 pages; Jones & Laughlin Steel Co., 1916, 388 pages; Lackawanna Steel Co., 1915, 456 pages; and Phoenix Iron Co., 1915, 248 pages.

The "Catalog of Bethlehem Structural Shapes" is, as called, a catalog rather than a handbook. The Bethlehem company handbook, "Structural Steel," issued in 1907, has not been continued. Only one edition was printed.

The information given in the Phoenix book is confined mainly to the properties of iron and steel. The introduction states, "No attempt has been made to compile a textbook covering the design of steel structures."

A brief comparison of these books may be of interest. They necessarily have much in common, and each manufacturing firm gives prominence to its own products. They contain a wealth of data and information invaluable to the structural engineer. The personal equation always enters into the selection of material for a compilation. Cambria devotes 23 pages to areas and circumferences of circles, giving two tables, one advancing by tenths and another by eighths, for diameters ranging from 0 to 100. Twelve pages are given to square and round bars. Carnegie, Jones & Laughlin and Phoenix give an unusually complete table of the functions of numbers from 1 to 1000. Phoenix devotes 30 pages to an exhaustive table of weights per lineal foot of steel plates from $\frac{3}{16}$x1 in. to $1\frac{1}{2}$x$120\frac{3}{4}$ in. for each $\frac{1}{16}$ in. of thickness and $\frac{1}{4}$ in. of width.

For the safe load in direct compression on steel columns Bethlehem uses the formula $16{,}000 - 55\frac{l}{r}$ for lengths over 55 radii of gyration and 13,000 for lengths under 55 radii; Carnegie and Phoenix use $19{,}000 - 100\frac{l}{r}$ for lengths from 60 to 120 radii, 13,000 for lengths under 60 radii and $13{,}000 - 50\frac{l}{r}$ for lengths over 120 radii; Cambria and Lackawanna use the Gordon formula, $P = \dfrac{12{,}500}{1 + \dfrac{(12L)^2}{36{,}000r^2}}$; Jones & Laughlin uses $16{,}000 - 70\frac{l}{r}$ for lengths between 30 and 150 radii and 14,000 for lengths under 30 radii. Carnegie, followed by Jones & Laughlin, considers loads on column brackets. Both err in using Rankine's formula for eccentric loading to determine the stresses for the case illustrated.

The strength assigned to beams unsupported laterally varies greatly. According to Bethlehem and Phoenix 80% of the tabular strength should be taken for a beam having a span 40 times the flange width without lateral supports. According to Cambria 73% should be taken, while Carnegie and Jones & Laughlin give 43%. Lackawanna makes no mention of beams unsupported laterally. This omission is unfortunate, for the inexperienced are liable to use the full tabular strength for all beams. Carnegie, followed by Jones & Laughlin, gives very convenient tables of the allowable uniform load on beams and channels in pounds per lineal foot.

The subject of grillage foundations is taken up by all except Lackawanna. It is noted that they agree in locating the maximum bending moment of a grillage beam at the center of the beam, correcting a grievous error found in some earlier editions. There is not the same agreement, however, in the determination of bearing plates for beams. Carnegie and Jones & Laughlin include calculations of rolled-steel slabs.

The location of the principal axis of unequal-legged angles is given in Cambria and Lackawanna. For the location of the principal axis of Z-bars it is necessary to refer to earlier editions of Cambria.

Cambria, Carnegie, Jones & Laughlin and Lackawanna give a formula for wind pressure on roofs, but it is the old Hutton or Unwin formula that has long been discredited.

Cambria fills 22 pages with an elaborate analysis of the building laws of 31 cities. This seems longer than necessary, for building codes are changed so often that these pages cannot be quoted as authority. Moreover, a clause in one part of a code is sometimes modified by a clause in another part which a tabulation fails to show. The two pages of "Contents of Storage Warehouses" in Carnegie are original and valuable. Wooden beams and columns receive attention in 21 pages of Cambria and in a dozen of Carnegie and Jones & Laughlin. Cambria and Carnegie give a few pages to reinforced concrete.

The question will here be raised, Why not have a standard notation for beam flexure? Why should Bethlehem and Cambria use such diverse systems? Or why should Jones & Laughlin and Lackawanna differ as they do? At present every textbook on mechanics or stresses is a law unto itself in its notation and is liable to remain so as long as there is no agreement among compilers of handbooks.

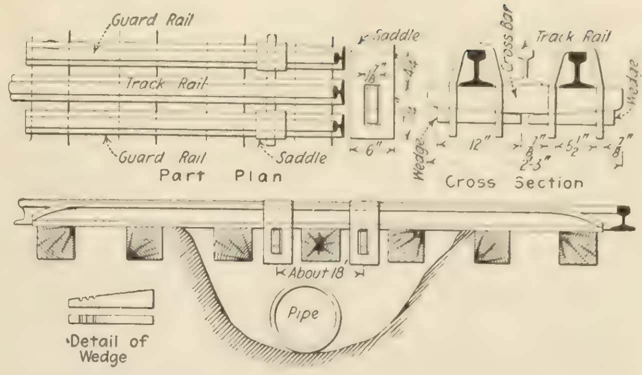
In concluding, attention is called to two leading English handbooks. The "Pocket Companion" of Dorman, Long & Co., Ltd., 1915, xl + 240 pages, is similar to American handbooks and calls for no special remarks. Of course, English terminology is used throughout.

The handbook No. 16, July, 1915, "Structural Steel," of R. W. Skelton & Co., 320 pages 6½x8½ in., is unique in its contents, arrangement, thumb-indexing and typography. It is stated in the introduction, "Except for the mathematical tables or where express acknowledgment is made to the contrary, the contents of this book are entirely original both in substance and form." The scope of the book is confined mostly to structural steel. Alone among the handbooks mentioned it quotes the well-established Duchemin formula for wind pressure on roofs. The "Nomogram" is introduced, and a number of these diagrams are found throughout the book. The notes regarding delivery of steel of the various sections are especially valuable. A few pages are given to "American" standard beams, channels and specifications. The last 20 pages are taken up with photographs of structures fabricated by Skelton & Co.

Supporting Tracks Across Trenches

Digging trenches through railway fills for culverts, pipe lines, etc., usually necessitates placing timbers and blocking under the ties, with increased excavation to put in this timbering. A method devised to reduce the amount and cost of such excavation consists in the use of short guard rails on either side of the track rails, carrying saddles with crossbars that support the track rails, as shown in the drawing.

The guard rails are about 10 ft. long, with ends beveled so as not to catch hanging chains or hose. Pieces of scrap rail can be utilized. These rails are laid on the ties, so as to span the location of the trench. Over each rail is placed a saddle having slots in the vertical legs below the level of the rails. A crossbar of 1¾-in. iron, with bottom sides tapered, is slipped through the legs of the two saddles, and wedges driven beneath it in the slotted holes force it to a bearing against the base of the track rail. For a trench 4 ft. wide one support is considered sufficient, while for a 5-ft. trench two supports should be used and the sides of the cut braced to prevent caving.



DEVICE FOR SUPPORTING RAILWAY TRACK ACROSS TRENCHES

This device is in service on a number of railways. It is the invention of R. S. Bohannan and is made by the Bohannan Easer Joint Co., of Ensley, Ala.

Barge with Plow Lays Cables 12 Ft. Below Bottom of Channel

By Paul J. Ost*

The City of San Francisco operates four drawbridges over narrow waterways where the regular traffic averages more than two boats per hour. At one of these bridges it was necessary to lay a new submarine signal cable having an outside diameter of 1¾ in., and at another bridge two control and signal cables, each having an outside diameter of 4 in. The channel, spanned by both of these bridges, has not been dredged for some time, and the present mud line is more than 10 ft. above the level to which the channel will be dredged. In order to lay the cable below the dredge line, it was necessary to sink it through about 12 ft. of fairly soft mud. The traffic, the character of the mud and expense made the dredging of a trench out of the question. The Butte Engineering and Electric Co., San Francisco, which had the contract for the work, devised the equipment described and illustrated.

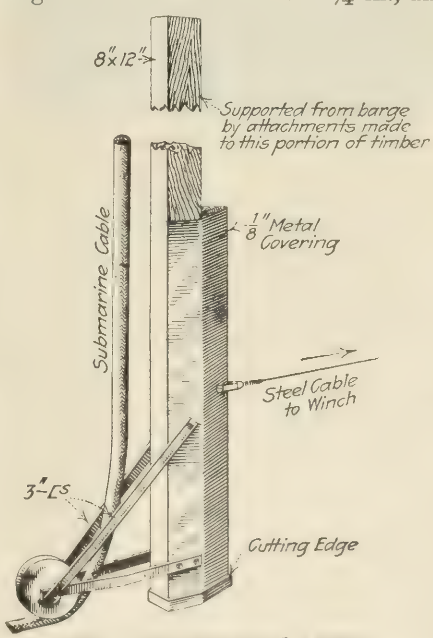


FIG. 1. PLOW FOR LAYING SUBMARINE CABLE

*Electrical Engineer, Bureau of Engineering, City of San Francisco.

The cable reels were loaded on a barge, which was equipped with the plow shown in Fig. 1. This plow consisted of an 8x12-in. timber 36 ft. long, shod for 10 ft. at one end with a cutting edge of ⅛-in. sheet iron formed over a wooden wedge attached to one side of the main timber. Projecting from the timber on the side opposite the cutting edge, a channel-iron frame supported a sheave to carry the submarine cable. The plow was drawn by a steel cable from an electric winch located on the shore. The barge was steadied by two small steel cables run over hand winches set at either end of the barge.

The plow was forced into the mud to the proper depth by means of a chain-block so arranged as to tend to lift the weight of the barge on the plow. When the proper depth was reached, the plow and barge were drawn to the opposite side, and the plow was lifted. This operation was repeated several times to loosen the mud before attempting to lay the cable.

After the mud was sufficiently loosened, the plow was brought to the surface, and the end of the submarine cable was led downward through the sheave to the point of termination at the abutment of the bridge, where it

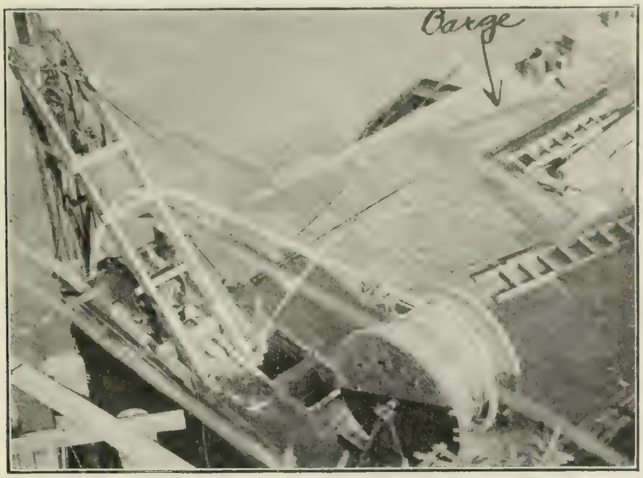


FIG. 2. BIRDSEYE VIEW OF CABLE-PAYING RIG

was made fast. The plow was then lowered into the mud, the cable being paid off the reel at the same time. When the plow had reached the proper depth, it and the barge were again drawn to the opposite side by the electric winch. As the equipment moved, the cable was unreeled into the furrow behind the plow, without a strain of any kind being applied to it. At the far side the plow was raised, the cable being allowed to remain slack, and the sheave was unshipped. The end of the cable was then free to be taken to the terminal box on the bridge abutment.

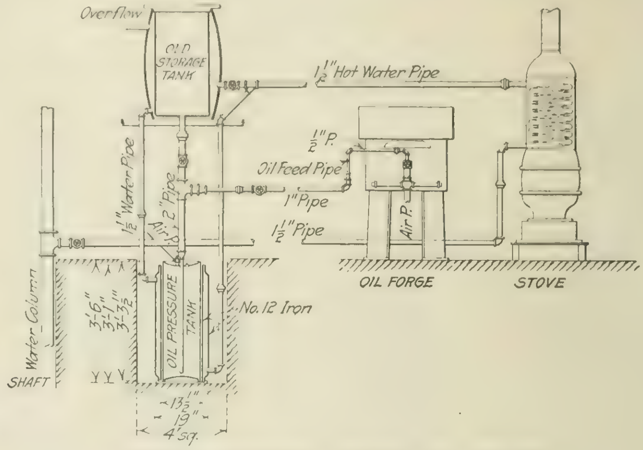
The crew employed on this work consisted of a foreman electrician, an electrician and three laborers. The work could have been handled more easily had sailors been employed in place of common labor, as they naturally are more familiar with handling the ropes and tackle required on a boat. The work was accomplished, however, using the class of labor available.

In this manner it was possible to lay the cable at a known depth without blocking the waterway for more than 30 min. at a time, and at a very moderate cost. All of this work of laying the submarine cable was under the direction of M. M. O'Shaughnessy, City Engineer of San Francisco.

FINE AGGREGATE

Print Profile and Cross-Section Paper on Both Sides is a suggestion offered by Samuel P. Baird, Columbus, Ohio. Mr. Baird says he has recently used a quantity of both kinds of paper in connection with one job and that all but one of the plottings must be discarded. The suggestion is offered in the interest of contractors and engineers, to whom such paper, printed on both sides, would mean money saved.

Oil-Storage for Drill-Sharpening Shop—An oil forge is employed in the steel-sharpening shop of a certain mine in Missouri. Originally it was planned to supply oil for the forge by gravity flow from an overhead tank in the shop, but objections by the underwriters made it necessary to place an oil-pressure tank outside the building, as shown in the



A 50-GAL. FUEL-OIL STORAGE SYSTEM

sketch. The oil is maintained at the proper temperature by means of hot water from a coil placed in a stove. The water is supplied to this coil from the mine-pump discharge column and circulated through a hot-water jacket around the oil tank, rising thence to the upper barrel, which contains a 50-gal. oil tank.

State Highway Bridge Built by County—A steel highway bridge designed for two 15-ton traction engines passing each other was recently completed across the Santa Clara River on the main inland road between Los Angeles and San Francisco. It was built by Los Angeles County on the request of the State Highway Commission, as part of the improvement of main highways in the state. The main span is 200 ft., with a 35-ft. plate-girder approach span at each end. The floor is

A HEAVY ROAD BRIDGE, BUILT BY LOS ANGELES COUNTY FOR THE STATE

1 : 2 : 4 slabwork. The structure was designed by H. E. Warrington, county bridge engineer, and F. H. Joyner, road commissioner. Bridges built under the State Highway Department's request will be maintained by the state and, if destroyed, will be replaced by the state. The call was for bridges of either steel or concrete, assuming 15-ton traction engine loading for the steel bridges and 20-ton machines for the concrete bridges.

Editorials

Why Not Reduce Water Rates?

The mayor of Woburn, Mass., is seeking legislative authority to use $10,000 a year of water income for general municipal purposes. He urges that, although the water-works are owned by the city and produce surplus earnings of $15,000 to $20,000 a year, a legislative mandate requires all the surplus to be used for improvements instead of part of it going into the city treasury as profits and to reduce the city tax rates.

It seems pertinent to ask why not reduce the water rates, if they are producing a profit not needed for operation, capital charges and yearly extensions? Why should the water rates be made high in order that the tax rate may be made low?

Whatever the facts as to profits are at Woburn, some other Massachusetts cities are operating their works at a loss or, at least, letting the works go to rack and ruin through lack of proper management and financing. Reference was made in these columns on Feb. 15, p. 285, to comments on unsatisfactory diversion of water-works funds in Massachusetts cities, as stated in a report to the legislature from the State Department of Health. In a printed copy of this report, just received, it is said that, owing to lack of proper maintenance and renewals, the water-works of a Massachusetts city in which the water-works income had been used for general city purposes had deteriorated to such an extent that it had been necessary "to borrow money for the renewal of the water-works, while the surplus income therefrom was being used for the general expenses of the city—an indirect method of borrowing to meet general municipal expenses." This is certainly adding confusion to confusion. Apparently, that city thought it was really operating its works at a profit and using the profits to reduce taxes.

It is high time that such confusion in American water-works management by municipalities be brought to an end, so that, if it is decided to reduce general taxes at the expense of the water consumer, the result will not be an eventual addition to his tax bill.

Temporary Building Structures Are Often Neglected

Sometimes it is good to have a structure very unsafe, instead of just moderately so. In a case at Lawrence, Mass., many lives were saved because the roof trusses fell down before the building was finished and occupied. A contributory providential cause was a heavy snowstorm.

Like many temporary structures, this one was anything but uniform in its proportioning, and as it happened the weakest parts were very weak indeed. Had the trusses been a little stronger, or had the snowstorm come along a little later, the accident would have been of a more serious kind.

The Lawrence hall is not the first, nor will it be the last, temporary structure to fail. But there is at present one important difference between permanent and temporary structures whose elimination in the future may reduce such accidents: namely, the fact that temporary structures get distinctly less attention from building codes and building inspectors, as well as from designers. The carpenter who puts up a temporary stand or hall by eye and judgment is the first one to introduce an element of risk. But the building law that neglects to specify precisely concerning temporary work, and the inspector who is apt to leave the whole matter on the carpenter's conscience, increase the hazard very greatly. This is particularly true of roofs, for with floors and reviewing stands the full loading is so obvious and definite that at least posts and joists are usually of safe sizes.

There exists a convenient and seductive idea that temporary structures may have a smaller margin of safety than those built to last. How far is this idea justified? How much reduction of safety margin may be allowed? These are nice questions. We believe that the applicability of the idea, insofar as it is justified at all, is very limited. In any event, it may be put down as sound dogma that proper designing and proper inspection are as essential for temporary as for permanent structures.

The perplexing fact that many of these structures are so arranged that their stress distribution is uncertain should not militate against using the conservative principle of figuring the weakest stress distribution, within reason. The hurry governing most temporary work should not lead to neglect of details, or sanction making them weaker than their connecting members. Splices, knees, bracing and bearings should have as careful attention as in a structure built to endure through a generation.

Water-Power Bill Fails in Congress

The ending of the 64th Congress without the passage of the Water-Power bill and other legislation in which engineers are deeply interested was indeed nothing but what had been expected; but it is none the less a deep disappointment, in view of all the labor that has been expended during the past two years in framing legislation that would harmonize conflicting ideas and enable water-power development to go forward. President Wilson, in his appeal to the public on March 4, made special mention of the Water-Power bill, the bill for leasing public mineral resources for development, the Webb bill for facilitating the development of American export business and the bill for reorganizing the Interstate Commerce Commission, as examples of legislation which ought to have been enacted and would have been except for the obstructive tactics of a minority.

Never in the nation's history has it been so clearly brought home to public comprehension that the nation's welfare is dependent on the ability of Congress to do things. Never has the necessity of radical reform in Congressional methods been more clearly demonstrated.

Another Underpaid City Engineer

The civil engineers of Omaha, Neb., according to a press report, are complaining because the city engineer is a member of a local engineering firm, and hint that because of this association an undue proportion of city surveying work is falling to the share of that firm. A local newspaper pointedly remarks: "Other engineers say the possibility of overlooking errors is greater when the city engineer approves work done by his own firm."

The civil engineers of Omaha could accomplish far more for themselves and for their profession if they would direct their complaints and sarcasms at their city government for the miserly way in which it compensates its engineers. The newspaper quoted states that the salary of the city engineer was recently raised from $3000 to $3600 per annum, and of the assistant city engineer from $2100 to $2400 per annum. Fine compensation, indeed, for men whose duties include the control of public-works construction of a rapidly growing city of 165,000 population!

Worcester Sewage-Treatment History

The history of sewage treatment in Worcester, Mass., reviewed briefly elsewhere in this issue, is an epitome of the history of the art in this country for the past three decades. That is not all. After 35 years of study, experimenting and practical operation on a large scale under the best guiding minds of the country, Worcester today is compelled to ask for time in order to make further studies before it decides just how to meet an imperative demand for more complete treatment.

The processes tried at Worcester—some on large and some on a small scale—have been chemical precipitation, slow sand filters, the plain septic tank, contact beds, trickling filters, the Imhoff tank and now, actually or in early prospect, activated sludge. The Imhoff tank and trickling filters would doubtless be adopted today, were it not for the hopes inspired by the latest great promise in sewage treatment—the activated-sludge method.

Broadly speaking, for many years no one has thought of adopting chemical precipitation for new installations. The plain or one-story septic tank also seems to have had its day, except perhaps for small plants or special local conditions. Slow sand filters require material notable for its scarcity in many parts of the country, and they also demand large areas of land not likely to be available at feasible cost near cities of any size. The contact bed soon yielded to the trickling filter, again except under special local conditions.

The early promise of the activated-sludge process was that in a single simple tank, with sludge as the only contact medium and air under pressure as the only agent, sewage could be treated at will to any required degree while the final sludge would be high in nitrates and thus a valuable fertilizer base. The process still has high promise, but it does not seem so simple and self-contained as it did. Neither its cost nor the commercial value of the sludge has yet been so generally and conclusively established as to make further experiments unnecessary for each engineer and each city approaching the process for the first time.

It is to be hoped that Worcester, with its wealth of experimental and practical data on other processes of sewage treatment, will give the activated-sludge process as full a test as may be needed to determine how it will suit local conditions. Another Massachusetts city, Brockton, seems to be about committed to activated-sludge treatment to provide an effluent for its sand filters. Its proposed action is based on careful studies. Should both of these cities build activated-sludge plants, all sections of the country would see the process under large-scale practical tests—a condition much to be wished, since engineers and cities everywhere are waiting for confirmation of their hopes that another decided advance in sewage treatment has been made, one giving at least another successful process to choose from in seeking to meet local conditions, even if it does not prove to be the one all-inclusive, all-sufficient solution of the sewage problem.

Cement Kilns and Blast Furnaces as Producers of Potash

It is a matter of common knowledge nowadays that the world's food supply is dependent on a sufficient amount of nitrates, potash and phosphoric acid in the soil in which crops are grown. These elements are constantly being removed from the soil by the growth of crops; and a large proportion is eventually discharged into the sea through the operation of modern water-carriage sewerage systems.

In order to supplement the slow processes of nature in restoring fertility to the soil through the decomposition of mineral matter, agriculture in all civilized countries has come to rely largely on artificial fertilizers, the chief ingredients of which are the three elements above named. Of these three, nitrogen is obtainable from the air, both by the processes of plant growth and by recently developed electrochemical processes. Of mineral phosphate, the United States has enormous deposits. For potash, however, the United States, in common with the rest of the world, has had to rely upon the mines of Germany.

Since the outbreak of the war, which cut off the supply of potash from Germany, the problem on which thousands of earnest workers have been engaged has been the development of a supply of phosphate from native sources. There are vast amounts of potash contained in certain rocks. Feldspar, for example, contains a large percentage; but methods of concentrating this potash and putting it into marketable shape on a commercial basis are yet to be developed. Within the last few months, however, it has been discovered that the dust discharged from the cement kiln and from the blast furnace, which has hitherto been chiefly important because of the nuisance that it creates, is rich in potash and in a form that makes it directly available for use as a fertilizer.

In *Engineering News* of Dec. 28, Arthur C. Hewitt, Chief Engineer of the Security Cement and Lime Co., of Hagerstown, Md., described the pioneer plant that his company has established for collecting the dust from its cement plant for use as a fertilizer. This plant with its five kilns in operation is producing 20 to 25 tons of dust per 24 hours, containing 5 to 10% of pure potash in the form of a sulphate. At the Security plant the Cottrell process of dust precipitation is used.

There would appear, however, to be a still simpler method of extracting a large part of the dust from cement-kiln flue gases. At the recent annual meeting of

the American Society of Mechanical Engineers a paper was read by Arthur D. Pratt on "Steam Boilers for Utilizing Waste Heat." One section of this paper was devoted to the application of waste-heat boilers to cement kilns. The gases leaving the end of a cement kiln are at a temperature of 1300° to 1800° F. The opportunity for utilizing their heat for generating steam is obvious; but up to the present time, according to Mr. Pratt's paper, only four cement plants in the United States have installed waste-heat boilers. These are the plants of the Cayuga Lake Cement Co., at Ithaca, N. Y.; the Sandusky Co., at Dixon, Ill.; the Burt Co., at Bellevue, Mich.; and the Louisville Co., at Speeds, Ind.

Mr. Pratt's paper describes in detail the large saving effected through utilizing the waste heat for generating steam, and he also devotes some space to the action of the waste-heat boilers in extracting dust from the waste gases. This dust, according to Mr. Pratt's paper, is merely taken back and fed to the kiln again. The dust is largely composed of burned or unburned cement clinker carried along by the blast, and its feeding back into the kiln has saved the use of just so much raw material.

It is evident, however, that the composition of the dust deposited from the kiln gases will be the same whether it is precipitated by the Cottrell electrical process or whether it is deposited in the course of its passage through the boilers and their settings. If the raw materials used at the plants named are as high in potash as those used at the Security plant, it is evident that the dust collected at the boilers should be as valuable for fertilizer in the one case as in the other.

According to the figures given by Mr. Pratt, the dust collected at the Burt plant amounts to about 2½ tons per kiln per day, or about 3% of the total weight of material fed to the kiln. At the Louisville Co.'s plant the boiler setting and the flues connected with the kilns are specially designed with the object of settling out as much dust as possible to avoid collection of dust on the boiler tubes. The dust collected at the Louisville plant amounts to 3.9% of the total weight of the kiln charge. This appears to be a little more than half the amount of dust collected from the kilns at the Security works by the Cottrell process, which Mr. Hewitt gives as 4 to 5 tons per kiln per 24 hours.

From these figures, a Cottrell process plant to treat the flue dust after passing through the waste-heat boilers might be worth while. Such a plant could be considerably smaller and would involve less difficulty in construction and operation than the plant installed by the Security Cement Co., since it would deal with the gases at much lower temperatures, probably 400° to 500° instead of 1300° to 1800°. The cooler gases would occupy a much smaller volume, and there would be less difficulty with the apparatus on account of the intense heat.

The question that naturally arises is where the potash comes from which is thus collected. Mr. Hewitt's paper is silent on this point. An interesting light is shed upon it by a paper entitled "Potash as a Byproduct from the Blast Furnace," by R. J. Wysor, superintendent of blast furnaces of the Bethlehem Steel Co. This paper is published in the January "Bulletin" of the American Institute of Mining Engineers.

It appears that the Bethlehem Steel Co. is collecting the dry dust deposited by the blast-furnace gas passing through the furnace stoves and boilers and has shipped 1073 tons of this dust in the 15 months since Apr. 1, 1915, to July 1, 1916. This is the dust collected from the operation of four 500-ton blast furnaces, and it will be obvious that the amount of potash recovered from the blast furnace is a much smaller percentage of the material fed into it than is the case with the cement kiln.

This is partly due to the fact that at present only a very small percentage of the potash discharged from the blast furnace is saved. An extensive investigation carried out by the Bethlehem Steel Co., of which Mr. Wysor presents the results in his paper, shows that only 1.3% of the potash present in the materials charged into the blast furnace is recovered in the dust now collected. A considerable part of the potash is lost in the slag and in other ways which cannot be prevented, but there are various possible methods by which a much larger proportion of the potash could be recovered, provided it were commercially advantageous to do so. The Bethlehem plant has in fact experimented with a Cottrell dust precipitator and has found it practicable to collect a dust with an average of 10% potash content.

In discussing the source of the potash in the blast furnace Mr. Wysor expresses the opinion that the chief source of the potash is feldspar or clay mixed as an impurity with some of the materials entering the blast furnace. These impurities perform no valuable function in the operation of the blast furnace; on the contrary, the effect of the alkali on the firebrick lining of the hot-blast stoves is exceedingly injurious.

While in the blast furnace clay occurs only as an accidental impurity, in the cement kiln it is one of the main elements in the charge. It can readily be understood therefore why the cement kiln promises a much larger possible output of potash as a byproduct than does the blast furnace. Should the collection of potash as a byproduct become a permanent feature of cement manufacture, it may become worth while to study the chemical composition of different materials available for cement production. It is entirely probable that great variation will be found in the potash content of the various clays and limestones used; and by choosing materials rich in potash, it may be possible to increase materially the profits of a plant from its sales of potash dust.

Of course, any commercial determination of the future possibilities of potash production from the cement kiln will be dependent on the market prices for potash after the German mines are again available to the world. Even though cheap potash from abroad were to make it unprofitable to collect potash from cement works located on the Atlantic Coast, however, it might still be profitable for cement plants in the remote interior, where the freight rate makes imported potash costly, to manufacture byproduct potash to supply the local demand for fertilizers.

There is every reason to believe that the demand for chemical fertilizers to maintain the fertility of soils is destined to increase enormously the world over. Fertilizer manufacture is like cement manufacture in that the value of the product per ton is so low that there is a strong tendency for the manufacture to spread all over the world. It is quite within the possibilities, therefore, that the wide distribution of portland-cement manufacture may have an important relation to the maintenance of soil fertility and the world's food supply.

Letters to the Editor

I. K. Brunel and the Hungerford Bridge

Sir—The anecdotes of I. K. Brunel in "Engineering News," Jan. 13, 1917, p. 68, contain some inaccuracies as to the Hungerford bridge. This bridge did not cross a gorge, but crossed the River Thames at London in a very flat location. Its span was 676½ ft., with side spans of 333 ft. In 1831, Mr. Brunel proposed a suspension bridge over the gorge of the River Avon at Clifton, a suburb of Bristol, and a cable was stretched in 1836; but the scheme was abandoned in 1853 owing to lack of funds. In 1841-45 he built the Hungerford suspension bridge over the River Thames at London, near the site of the present Charing Cross bridge. In 1861 (two years after Mr. Brunel's death) this bridge was removed to make way for a heavier structure. The material was purchased by John Hawkshaw and W. H. Barlow, who were engineers for the revived project of the Clifton bridge at Bristol. As rebuilt by them over the Avon, it had (and has) a span of 702 ft., with a height of 245 ft. above the water; it has no flanking or shore spans. "BRIDGE."

Chicago, Feb. 24, 1917.

Training Teachers of Engineering

Sir—In your issue of Feb. 8 there is an article of exceptional merit by A. M. Shaw, Esq., Consulting Engineer, entitled "Should Not Engineering Teachers Know How to Teach?" It is of such importance that I desire to emphasize its main sentiment and to amplify it by adding a few suggestions of my own.

Mr. Shaw is right when he indicates that one of the principal defects in engineering curricula is a general weakness among the younger teachers. This is due to several causes, of which the following are the most important:

1. Taking men directly from the graduating classes and making them instructors.
2. Adherence to the pernicious habit of excessive "inbreeding."
3. Employing teachers who know nothing about the science of pedagogy.
4. Permitting men to teach who have no natural aptitude for imparting instruction, or who are working mainly for the financial compensation which the work entails.
5. Failure to pay salaries that are large enough to induce capable men to leave engineering practice and adopt pedagogy.

In respect to the first cause, there are two sound reasons for the objection raised, viz.:

A. No one can properly teach engineering whose knowledge has been obtained solely from books; because, in addition to knowing the "why and wherefore," he must be posted concerning the "how and do." In my opinion, it is unwise for any technical institution to employ on its teaching staff any man who has not had, subsequent to graduation, at least three years of practical experience—and most of it in the field.

B. A recent graduate when teaching at his alma mater is on terms of too great intimacy with the students to permit of his having proper influence over them. This is objectionable not only because of the matter of maintenance of discipline but also because students should regard their instructors with a certain amount of respect—which is likely to be lacking if previously there has been close intimacy between them.

As for "inbreeding," or the selection of instructors from the graduates of the school, it is objectionable mainly because it tends toward getting the teaching into ruts and toward the suppression of innovations that would be in the line of improvement. It should be stated, however, that the longer an engineer has been in practice since graduation, the less important is the objection to having him on the teaching staff of the institution where he studied; because by mixing with the alumni of other technical schools his ideas concerning education become broadened, and because, in connection with large enterprises, his contact with the workers thereon gives him an indication of what are the good features and the defects of the various schools of engineering.

Ignorance of the science of pedagogy, as pointed out by Mr. Shaw, is a most serious handicap to the success of any institution where it is permitted to exist; and allowing those to teach who are lacking in natural aptitude or who are governed essentially by sordid motives is a crime.

Failure to pay adequate salaries to instructors, both young and old, is a condition which obtains today in almost all American technical schools. It is their most serious stumbling-block in the pathway of progress, and is an evil which should be corrected with the least possible delay. Technical instructors have always been paid less than their services are truly worth; and the small increases of salaries which have been made of late years have not kept pace with the augmenting cost of living.

J. A. L. WADDELL, Consulting Engineer.

Kansas City, Mo., Feb. 13, 1917.

Sir—The great increase of attendance at our colleges and the failure to secure corresponding increases of income with which to meet the increased demand upon the capacity of the institutions has brought about a condition in education similar to that which in trade has given rise to the department store and in manufacture to the application of efficiency engineering. The profits of the 10-cent stores and automobile factories justify to the business man the adoption of his methods, and this idol of the American people exhibits his wisdom in matters educational by the creation of costly buildings and beautiful grounds and a large corps of inadequately educated and incompetent instructors.

The number of able men available at the rates which are usually paid for instructors, who do practically all of the college teaching in the first two years of the course, is very small. If those responsible for the management of our institutions of learning would publicly admit their failure through lack of funds to properly meet the demand for education the matter would be simplified.

One of the evils resulting from this condition is the development of a class of instructors inclined to turn up their noses at the duties of teaching, but who lay great emphasis on their ability to piece out their incomes in private practice. It is agreed by all that for the young man who aims to become a teacher it is well that he should have practical experience, both for his own sake and for the sake of the institution which he serves and of the students he is to teach. But unless methods of securing such experience are carefully defined by older and wiser men the resultant abuses are very harmful to the students.

No man should be allowed to enjoy the relation of instructor, teacher, or adviser to the most precious product of our country unless he is willing to give himself wholeheartedly to the task of furthering the development of our sons and daughters to the end that they may reach the highest attainable achievements.

What we need is a training of the popular thought to the end that men may strive for ideals rather than for the accumulation of dollars, and if in the present world confusion the value of the dollar is so disturbed that no man can know what it shall be, the reversion to the earlier and finer things of life may be a blessing worthy in some degree of the tremendous sacrifices that are being made. ALBERT J. HIMES.

Cleveland, Ohio, Feb. 15, 1917.

Patented Materials on Federal-Aid Roads—Attention has been called to the inaccuracy of the statement in "Engineering News," Feb. 15, p. 290, in the report of the annual convention of the American Road Builders Association, that "Great interest was aroused by the clause in the regulations for applying Federal aid that none would be given for payment of royalties on patented materials." To save space the clause in question was not quoted in full (it was quoted in "Engineering News," Sept. 14, 1916, p. 521) and only its meaning, as apparently interpreted by those who discussed it, was given. According to the letter of the law, patented materials are not actually excluded. The clause reads:

> No part of the money apportioned under the act shall be used directly or indirectly to pay or to reimburse a state, county or local subdivision for the payment of any premium or royalty on any patented or proprietary material, specification, process, or type of construction, unless purchased or obtained on open, actual competitive bidding at the same or a less cost than unpatented articles or methods equally suitable for the same purpose.

A Base-Support Rail Joint

The rail-joint shown in the accompanying drawings supports the rails by their bases only, and these for a length of only 2½ in. at the center of the joint, instead of throughout the length of the joint. There is no bearing under the head of the rail.

In the cast-steel joint Fig. 1, the base and outer side are formed in one piece. The outer side also is carried up so as to have a lateral bearing against the outside of the rail heads; but the top of the joint is ½ in. below the top of the rail head, so that it is clear of the false flanges of worn wheels even when the rails are worn. In the rolled-steel joint, Fig. 2, the two parts are identical in shape, each forming one side and half the base support. In this joint the lateral member along the rail head is omitted.

The purpose of this design is to hold each rail as an individual member, avoiding the usual feature of splicing the rails so as to form a continuous girder. Thus the joint holds the rails in position at their ends, both vertically and horizontally, without performing the functions of a splice. It has the same strength and resilience as the rails, so that it does not constitute a rigid or hard spot in the track. As the bearing or rail seat is slightly lower at the ends than at the middle (where the rail

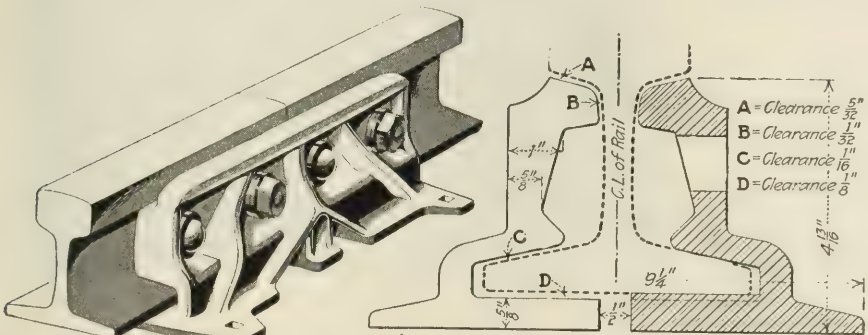


Fig 1 Perspective View of Cast-Steel Joint Fig. 2 Cross-Section of Rolled-Steel Joint

HINGE TYPE OF RAIL JOINT
The Roach joint is not a splice, but forms a hinge at the rail ends

ends have a permanent bearing), the joint allows for the deflection or wave motion of the rails under load. This is a special feature of the joint, and it is claimed that in this way reverse stresses are eliminated and the load is transmitted through the center of the joint to the tie, without making a fulcrum of the ties and causing rocking or pumping.

In the cast-steel joint, the outer or main side-bar (which is formed integrally with the base support) has a clearance of $\frac{1}{16}$ in. from the rail head at the center and $\frac{3}{16}$ in. at the ends of the bar. The bottom of the rail is $\frac{1}{16}$ in. clear of the base member of the joint, except at the middle of the joint. This is the only point of support for the rail, and here its base is tightly gripped by the joint, as shown. The light bar used on the inside of the cast-steel joint does bear against the head of the rail, but only at the middle, its ends being $\frac{1}{16}$ in. clear at both top and bottom. In the rolled-steel joint, it will be seen that this head bearing is eliminated entirely.

With this device the track is best laid with supported joints, having a tie under the center of each joint. It can be used with two-tie or bridge joints, having a tie at each end of the joint, but experience has shown that with the latter arrangement the joint ties remain high. The other ties (especially those of the quarter-points) then have to be raised, while ordinarily it is the joint ties that get low and have to be raised. With the supported or one-tie joint less maintenance is required than with the two-tie joint. The maintenance expense of either form of the joint is said to be very low.

This joint has been used for insulated joints on the St. Louis & San Francisco R.R. for about four years, and as an ordinary track joint it has been in service on other roads for about six years. It has been patented by H. F. Roach, President of the Reinforced Rail-Joint Co., Syndicate Trust Building, St. Louis, Mo.

Legal Decision on Liability of Street Railway for Track Paving

By O. E. Brownell*

In the district court, eleventh judical district, State of Minnesota, St. Louis County, case of City of Duluth, plaintiff, vs. Duluth Street Railway Co., defendant, the court has handed down a decision in favor of the city, which involves points of interest to municipal engineers.

The company's franchise provided among other things that in cases where "other than animal power is used, the company shall be required to pay only so much of the expense of paving the street as is made extra by reason of said railway." The company maintained that it was liable only for the extra cost of laying the pavement around its tracks over what it would have cost to lay the same pavement if the tracks were not there. The city claimed that in addition to the extra cost of paving around rails the company was liable for the cost of extra width of street made necessary by the existence and operation of the railway. If the tracks were not in the street, the city would have paved it 25 ft. wide, curb to curb, and on account of the street railway it was paved 42 ft. wide. The court held that the extra width was made necessary to the extent of 10 ft. for double track and 5 ft. for single track and also that the company was liable for extra expense of paving around tracks. The memorandum of the court contains the following:

1. The court finds as a matter of fact that the additional width of pavement was made necessary by the railway, and it has endeavored to fairly determine the extent thereof. The accuracy of such determination is uncertain. It is necessarily so. If the railway company is liable at all, it is only liable for such additional width "as is made necessary by reason of the railway." Yet there is no sharply defined line of distinction between necessity and convenience. It is impossible to say with absolute certainty that a given width of pavement is necessary and that any width in addition thereto is merely convenient. This matter presents a question of judgment only, upon which experts may and do honestly and excusably differ; and the finding of the court represents only its judgment arrived at with the aid of counsel, from the testimony of experts and others.

2. The parties to this contract must have anticipated that during the 50-yr. life of the charter there would be many changes and improvements in the operation of the railway, involving extra expense of paving; and it was apparently the

*Assistant City Engineer, Duluth, Minn.

purpose of the framers of the instrument to use general language which might cover all items that could not then be foreseen in detail. In the opinion of the court it would be unreasonable to hold that the parties to the transaction did not anticipate that during that 50-yr. period there might be such changes or improvements in engineering methods or in city planning as to create a condition where it must be held that the operation of the railway itself makes additional width of pavement necessary; and if it be true that the parties did anticipate such possibility, they did nothing to indicate any intention that the company should not be liable for extra expense because of such increased width the same as it is liable for extra expense on account of any other item increasing the cost of pavement.

In arriving at the amount of liability of the street-railway company, the court readjusted the unit prices bid by the contractor who did the paving. No difference was bid in price per square yard of paving between the regular paving outside of rails and that between and around the rails. The testimony, however, showed a difference in actual cost, and the railway company was held liable for such cost.

Up to the present time the unit prices bid on contract work have been the final basis for divisions of cost and assessments. In cases of unbalanced bids this has given an incorrect "division of the cost," among the parties sharing it—the property owners, the city and the street-railway company. Under this action it will be proper for the city engineering department to scrutinize all contracts for unbalanced bids and make a fair readjustment for purposes of division of cost and assessment.

Dry Rot in a Derrick Boom Causes Fatal Accident

By Henry Blood*

On Jan. 31, 1917, the boom of a stiff-leg derrick on the Public Auditorium in Portland, Ore., broke near the upper end and dropped a roof truss to the street. Two steelworkers were riding to the roof on the truss. One fell with it and was killed; the other jumped or was shaken off inside the building and escaped serious injury. Three roof trusses (besides the one that dropped) and several roof beams were damaged. The top of the wall was crushed for a short distance, and a section of scaffolding was destroyed. Broken pieces of wood from the end of the boom were found to be seriously affected by dry rot, although the outside appeared to be sound.

The derrick consisted of two stiff-legs placed at right angles to each other, a 30-ft. mast and a 90-ft. boom. The stiff-legs, sills and mast were composed of square timbers about 12x12 in., the bottom of the stiff-legs being about 32 ft. from the foot of the mast. One stiff-leg was placed north and south over roof truss T2, with the mast at the north end and about 40 ft. from truss T4. The other stiff-leg ran east to truss T3 (see Fig. 2). The main part of the boom was 70 ft. long and 15 or 16 in. in diameter at the larger end; it was spliced out to a length of 90 ft. by lapping another round timber of about 40 ft. along the under side and lashing the two together with wire rope at the ends and center of the lap (Fig. 3).

The contractor stated that this timber was five years old and that it had been stored in his open yard when not in use, where it was exposed to the weather. When new, it had been given a coat of linseed oil and one of green paint. He thought that an outside examination would not have indicated unsoundness and that the steelworkers would not have ridden on the truss if they had thought it unsafe.

There were two lifting blocks, one at the end of the main boom and one at the end of the spliced length. They had a four-part steel cable, and the same line ran through both, so that the strain was divided about proportionately between them. The hoisting line ran from the lower hoisting block to a sheave close to the end of the boom (see Fig. 3), followed the top of the boom to the mast and passed down through the turning pivot to the engine, which was located on the main floor of the Auditorium.

The boom was 10½ in. in diameter at the tip. It had a vertical slot 2 in. wide and 13 in. long for the hoisting-line sheave, a collar formed of two pieces of 1x6-in. metal with 1¼-in. bolts and heavy shackles for the hoisting and boom-raising blocks. There was a ½x4-in. strap on each side hooked around the outer edge of the collar and extending back about 3 ft. Four ¾-in. bolts and a 1¼-in. sheave pin ran through both straps and the timber. There was an old horizontal check extending from the tip to a point beyond the inner bolt, and an old vertical crack running both ways from the sheave slot, which divided the end of the stick into four parts. There was also quite a large sound knot near the end. The break that caused the accident was close to the inner ¾-in. bolt.

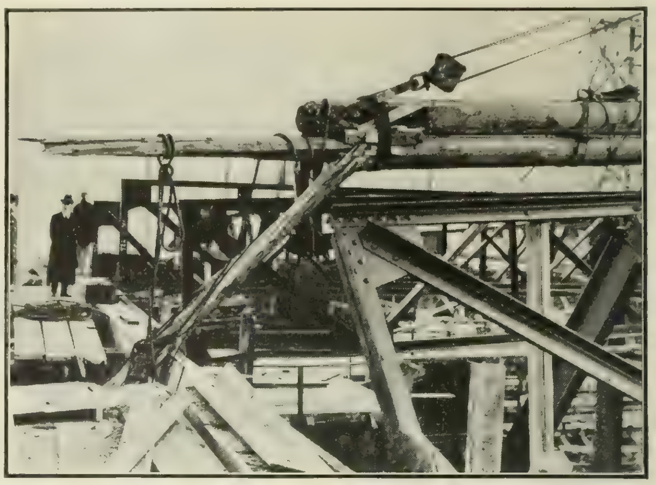


FIG. 1. DERRICK BOOM LYING ON ROOF AFTER FALL

The smaller roof trusses and beams were piled near the Third St. wall, as delivered. A number had already been raised and set in place, some being as heavy as, or heavier than, this truss T45, which weighs 5100 lb. The wall is 60 ft. high at the point of accident. Truss T45 had been lifted some distance above the wall and other roof framing and turned at right angles to the wall. The boom was at an angle of nearly 45°. Two or three sharp reports like rifle shots were heard by bystanders a few seconds before the truss reached this position. They appeared to come from the end of the boom. The end suddenly snapped off 3 ft. from the tip, the truss dropped on the outer roof beam, slipped down across the wall and fell to the street, carrying away the scaffolding as it fell. The blocks and cable went with it, and some cable was reeled from the drum of the engine. The boom immediately dropped to the roof, striking transversely another boom that was lying over truss T1, swung violently downward

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and split two or three large pieces from the end, one or two of which fell to the ground. Some electric wires on poles nearly as high as the wall were broken by the falling truss. The current was conducted to the roof steel, and several workmen in contact with it received shocks. The 10-in. beam that was struck by the truss was sheared off diagonally through the web at that end. The short end of the beam, hanging to truss T23, can be seen in one of the photographs. Several other beam connections were broken. They had all been bolted temporarily.

An examination of the broken timber showed that it was so affected by dry rot near the end that probably not 25% of the strength remained. Fungus growth was present in some of the splits. There was a thin shell of quite sound wood outside. Its condition could have been determined by boring a few small holes in it or probably by percussion. It had very likely been strained to the break-

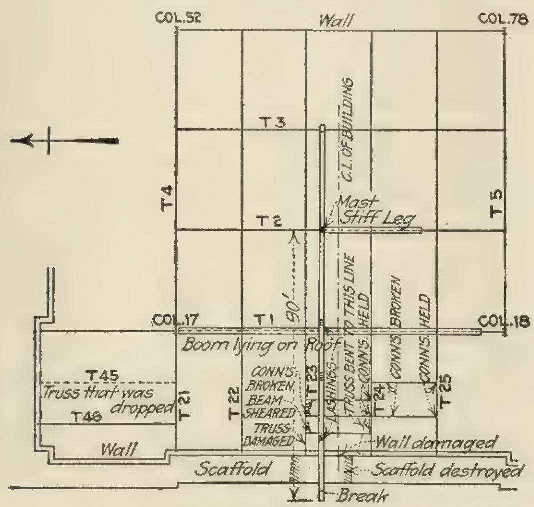


FIG. 2. LOCATION SKETCH OF ROOF AND DERRICK

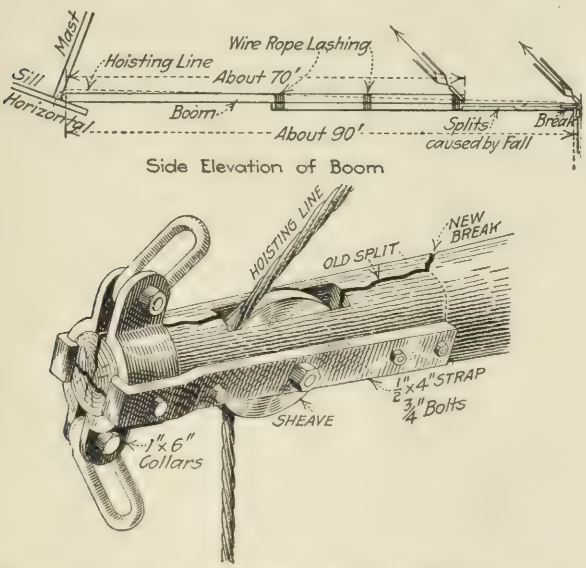


FIG. 3. BOOM SPLICING AND BREAK AT END

ing point by some previous load. The shape of the end connection and the fact that the spliced piece was not in line with the main boom would cause considerable eccentric stress when the boom was in its lower positions. The brake on the engine may have slipped and produced a shock on the cable; it was seen to slip a day or two later.

This adds to the lesson taught by a former accident on the Pittock Block that derricks and other erection apparatus should be given more attention by their designers and by the contractors and the city or state inspectors. The various parts should be strong enough to resist with a reasonable factor of safety any probable combination of direct and secondary stresses that may come upon them in different positions, and the timbers and cables should be carefully examined before use on each piece of work and at other regular intervals to see that they are in safe condition. Derrick timbers should not be left exposed to the weather for long periods when not in use; they are almost certain to be attacked by dry rot. Painting the outside may hasten and not prevent this.

Steel erectors should, as far as possible, keep the workmen from riding on loads, and they should be made more responsible by law for the proper construction, care and inspection of derricks and other erection equipment. This is not limited to steel structures, but applies to those of other materials; scaffolds on frame buildings are often built insecurely and sometimes cause accidents. Probably most accidents could be prevented by a little care and forethought. But it has generally been the practice to give consistent attention to the design and superintendence of permanent buildings and none to the temporary structures used in erection.

Ontario Municipalities Oppose Canadian Northern Ry. Extension

The projected 84-mile extension of the Canadian Northern Ry. from Toronto to the Niagara frontier was opposed by Sir Adam Beck, of the Ontario Hydro-Electric Power Commission, at the annual meeting of the Ontario Hydro-Electric Railway Association, held in Toronto, Feb. 21. He held that the people must now decide whether or not they want a national electrified railway system. The provincial Hydro-Electric Commission had spent $750,000 in preparing plans and estimates for the hydro-electric radial lines. He asserted that the Canadian Northern had not the means to build the projected line.

The Canadian Northern plans involve an expenditure of $7,000,000. Provision has been made for double tracks through all important centers, maximum grades of ½%, interchange connections with American coal roads, new receiving yards at Niagara Falls, Ont., bridges at Oakville, Bronte, the Desjardins Canal, the River Jordan and (ultimately) across Niagara River.

A letter was read from Sir William Hearst, Premier of Ontario, to the effect that the provincial government would stand behind the association in its protest against any interference with the hydro-radial movement by private corporations, and particularly in its protest against the granting of special privileges to the Canadian Northern Ry. Resolutions were adopted urging the government to proceed with the Chippewa development scheme as rapidly as possible; to amend the act providing for the construction of hydro-radial lines, so as to permit the immediate construction of lines authorized by the people; and protesting against interference by corporations and private interests against provincial projects and requesting the government to pass a remedial act safeguarding the rights of municipalities against the erection of poles and stringing wires without consent of the people.

News of the Engineering World

Atlanta Engineers To Aid City

A Board of Consulting Engineers to give advice and counsel to the city government of Atlanta, Ga., has been authorized by a recently passed city ordinance and members to the number of five have been named by the Affiliated Technical Societies of Atlanta. The appointees are: J. N. Hazlehurst, M. Am. Soc. C. E., G. R. Solomon, M. Am. Soc. C. E., A. M. Schoen, Am. Inst. E. E., C. P. Pool, M. Am. Soc. M. E., and Hal Hentz, M. Am. Inst. Arch.

The board will serve without pay. It is the intention of the city council to call on the board for technical advice and assistance on all the various engineering problems that arise—such as the paving of streets, planning and construction of sewers and sewage purification plants, the extension and development of the waterworks system, the electrical problems, fire protection problems, building laws, etc. Whenever some problem is referred to the board on which they desire the expert advice and cooperation of a specialist in that line, they will call him in and he will give the board the full benefit of a special study of that problem.

Reinforcing the Poughkeepsie Bridge

The famous cantilever bridge across the Hudson River at Poughkeepsie, N. Y., is to be strengthened and altered for the second time in its life, to adapt it to heavier loading. A special feature of the work is that the bridge will be changed from double track to single track, since the main structure could not be strengthened sufficiently to carry the new loading on both tracks. The bridge was completed in 1889 and forms a connection between the New York, New Haven & Hartford R.R. and railways west of the Hudson River.

The Poughkeepsie bridge has a central cantilever span of 546 ft., flanked by two anchor spans of 525 ft., and two cantilever spans of 548 ft.; the latter have anchor arms forming 200-ft. shore spans. The height is about 165 ft. above water level. The length of the bridge proper is 3094 ft., while the steel-viaduct approaches bring the total length to about 6760 ft. As built originally (and completed in 1889), the bridge had two lines of deck trusses on steel towers. These were spaced 30 ft. c. to c. and carried a double-track floor. In 1906 the bridge was strengthened for heavier loading by building a third line of trusses on the center line of the bridge, these being supported on new steel bents within the towers.

With the great increase in engine and train loading of the past few years the bridge could not safely carry these loads on both tracks simultaneously, nor could it be reinforced to such an extent as to do this. The alternatives were to eliminate the possibility of this double loading or to build a new bridge. The former plan was adopted, as the cost will be relatively small; and although the traffic is heavy, it can be handled without trouble over this single-track link.

The principal change on the bridge will be the reconstruction of the floor system, using long and heavy floorbeams that will distribute the load over the three lines of trusses. With the present double-track arrangement each track has an independent floor system. The spans and towers of the approach viaducts will be reinforced, and the new single track will extend over part of the length of these approaches. The rails of the two tracks will be gauntleted over this single-track section, so as to avoid the necessity of switch connections at the ends.

The plans for the altering and reinforcement of the structure were made by Ralph Modjeski, consulting engineer, of Chicago. The work will be done by the Strobel Steel Construction Co., of Chicago, and the material will be supplied by the Fort Pitt Bridge Works, of Pittsburgh. The work must be carried out without interfering with traffic and is to be completed during 1917.

The Denver Water-Works Situation

Attention is again called to the Denver water-works situation, already several times discussed in the columns of *Engineering News*, by the recent filing with the Public Utilities Commission of the City and County of a preliminary report by the Van Sant-Houghton Co. of San Francisco. The Commission originally entered into a contract with this company in July, 1915 (*Engineering News*, July 29, 1915, p. 234). Under the terms of this contract the company was to make a complete report with reference to the proposed construction of a new and independent water plant for the City and County of Denver, it being definitely understood, although not stated in the contract, that the report should be completed prior to May 1, 1916. On Feb. 21, 1916, however, the Commission entered into an option agreement with the Denver Union Water Co., the corporation furnishing water to the city, under the terms of which agreement the citizens were to have the opportunity of voting upon the the purchase of the existing plant upon the termination of litigation now pending before the United States Supreme Court, in which litigation a final determination as to the value of the said plant is involved. (*Engineering News*, Mar. 9, 1916, p. 483.) Under these circumstances the Commission no longer desired such a detailed report as was at first proposed, particularly when it became apparent that the preparation of such a report was going to take much longer than was at first anticipated by the Commission, and on Sept. 15, 1916, a new agreement was entered into with the engineering company to the effect that it should, not later than Oct. 5, 1916, conclude all work under the previous contract and submit a preliminary estimate on the cost of a new water plant. The report was submitted in the latter part of December, 1916.

The main features of the report are the conclusions (a) that it would cost \$27,479,500 to construct a new and independent plant for the city, this amount being approximately twice the present value of the existing

plant as determined by the United States District Court and more than twice the amount estimated as the cost of constructing a new plant by other engineers employed by the Commission; (b) that the supply of water in the South Platte River and its tributaries is insufficient for the requirements of the city without the purchase of the water rights now claimed by the Denver Union Water Co.; and (c) that the existing plant should be purchased under the provisions of the agreement of Feb. 21, 1916.

The plans suggested by the Van Sant-Houghton Co. include estimates of

Diversion from Blue River drainage, approximately	$7,500,000
Three large reservoirs, approximately	5,000,000
A concrete-lined aqueduct, approximately	3,000,000
Purification plant, approximately	2,000,000
City distribution system, approximately	10,000,000
Total	$27,500,000

The proposed system is, of course, far more comprehensive and modern than is the existing system, the total reproduction cost of which was estimated by the engineers employed by the Denver Union Water Co. to be $12,718,383, excluding values of water rights, going concern value and development expense.

The report is considered by the Commission as suggestive only and in no respect as final or conclusive. It is hoped that the matters now on appeal before the United States Supreme Court will be passed upon and that the citizens of Denver may have the opportunity of voting upon the purchase of the existing plant before the end of the current year.

Cincinnati Rapid-Transit Advanced

The draft of an ordinance outlining the terms of the lease for the proposed rapid-transit loop that the City of Cincinnati is to build as outlined in *Engineering News*, Apr. 6, 1916, p. 673, was presented to the council at a special meeting, Mar. 3. The first public discussion was at the meeting of the City Club the same day, and other public meetings are to be held soon. The ordinance will then be placed in final form for early passage. The terms of the lease provide for its submission to the qualified electors, and it will be voted on at the same time as the question of the home-rule charter, or on Apr. 17, 1917.

The proposed lease is for a term of 29 years, but the company must accept the theory of an indeterminate franchise. The earnings of the company are to be limited, and the city shall have control of operations and the right of purchase at specified times.

Form American Academy of Engineers

At the suggestion of Secretary Redfield of the Department of Commerce steps have been taken to form an American Academy of Engineers. Gen. George W. Goethals was asked to name ten engineers, who with himself will form the nucleus of the new organization. These ten are to select forty more members and the fifty, as incorporators, will ask Congress for a national charter. It is the intention to limit the membership to one hundred. The ten chosen by General Goethals are: Dr. C. F. Chandler, Professor of Chemistry, Columbia University, New York City; Dr. W. F. M. Goss, President, Railway Car Builders' Association; Dr. Carl Hering, Consulting Electrical Engineer, Philadelphia; Clemens Herschel, Consulting Civil Engineer, New York City; Dr. C. O. Mailloux, Consulting Electrical Engineer, New York City; Dr. S. W. Stratton, head of the Bureau of Standards, Washington, D. C.; Prof. A. N. Talbot, of the University of Illinois; Stevenson Taylor, Vice-President of the Quintard Iron Works Co., New York City; Dr. J. A. L. Waddell, Consulting Civil Engineer, Kansas City, Mo., and Charles F. Rand, Mining Engineer, New York City.

The Standardization of Salaries in all state departments is advocated by Governor James M. Cox in a budget submitted to the Ohio legislature.

The Bond Election to provide funds for rebuilding the Lower Otay dam in California has resulted in the bonds carrying by a comfortable majority.

A Snowslide Killed 15 Men when it destroyed the bunkhouse, compressor house and warehouse of the North Star mine near Hailey, Idaho, in the latter part of February. A fall of 2½ ft. of snow in three days followed by rain resulted in numerous slides in the district.

To Authorize Subway Construction in Pittsburgh, suitable legislation is being sought by the city officials in the state legislature. The bills introduced on their behalf are drawn so as to permit municipal construction of a rapid-transit subway to be operated by a lessor company.

Workmen's Cottages at the municipally owned garbage-reduction works of Dayton, Ohio, are proposed. The cost would be met from a bond issue to cover the cottages and plant improvements, the bonds to be cared for by the revenue from the plant. Six cottages at a reported estimated cost of $1500 each are proposed.

A Railway Collision Killed 20 Persons, according to press dispatches, when the Mercantile Express on the Pennsylvania R.R. was run into shortly after midnight on Feb. 27 by a fast freight at Mount Union, 43 mi. east of Altoona, Penn. The express had stopped to discharge passengers when the collision occurred. The three steel sleepers were telescoped but remained on the tracks; six of the freight cars laden with coal were thrown down a 40-ft. fill.

Reinforced-Concrete Pipe for Sewers has been used at Vincennes, Ind., for all storm-water sewers of 30-in. diameter and over, the maximum diameter being 66 in. No mechanical bond other than cement grout was used at the joints. The concrete for the pipe was a 1:5 mix of portland cement with sand and gravel. The reinforcement consisted of wire netting of triangular mesh. This pipe proved very strong, one 66-in. section being tested to 34,000 lb. for 24 hr. without destroying it. It was made near the work by Howard Schurmann, of Indianapolis, Ind., under the direction of H. T. Watts, City Engineer.

Los Angeles County Flood-Control Bonds to the amount of $4,500,000 came to vote on Feb. 20 in a hotly contested election. The official count showed a majority of 51 for the bonds, but there may be a recount. The project voted on was one for which plans were made by J. W. Reagan, Engineer of the Los Angeles County Flood-Control District, as outlined in "Engineering News" of Jan. 25, 1917. An earlier report, by a commission of engineers, recommended works estimated to cost $16,500,000 ("Engineering News," Feb. 10 and 17, 1916). A board of engineers consisting of J. H. Quinton, Charles T. Leeds and S. A. Jubb, appointed by the City Council, Chamber of Commerce and Municipal League, made a report on the Reagan plans and estimated the cost of the works contemplated in those plans as $12,518,200, instead of $4,450,000, and in addition held that portions of the Reagan plans were inadequate.

A County-Manager Charter for San Diego County, California, was defeated 2 to 1 on Feb. 27, only some 30% of the registered vote going to the polls. The county manager would have been the chief executive of the county and ex-officio purchasing agent, road commissioner and surveyor. He, in common with numerous other executive officers, would have been appointed by a board of nine supervisors, elected at large but representing specific districts. Another feature of the proposed charter was a civil-service commission. A local correspondent accounts for the defeat of the charter as follows: "The general sentiment appeared to be that the charter was the dream of theorists and presented too large an opportunity for building up a political machine controlled by one man, the county manager. Strenuous objection was also made on the ground that it deprived voters of their rights to elect numerous county officials which the new charter would make appointive."

The Third Annual Conference on Engineering Coöperation will be held in Chicago on Thursday, Mar. 29, at the rooms of

the Western Society of Engineers. The report of a subcommittee prepared subsequent to the meeting of Nov. 21, 1916, at Cleveland, Ohio, has been formulated and is in substance as follows: The work of the national engineering societies should be promoted, but greater stress should be laid upon the development of local engineering societies. Each local engineering society should be self-governed and free from dictation or control by any other association. Local societies should give special attention to the needs of the younger members. Each local engineering society should adopt and frequently make application of a code of ethics. The enforcement of such a code is essential to the well-being of a community as well as to the protection of professional men. An employment bureau should be organized and operated in coöperation with all engineering societies. Each local society should devote time and thought to local, civic, state and national affairs that influence engineering progress and should take an active part in considering proposed new laws.

PERSONALS

H. E. Wood, recently with the St. Louis Screw Co., St. Louis, Mo., is now with the Decatur Bridge Co., Decatur, Ill.

George A. Wardlaw, Editor of the "Electrical Record" since 1910, has resigned to engage in literary work on his own account.

S. L. Rice, Office Engineer of the Delaware, Lackawanna & Western R.R. at Hoboken, N. J., has resigned and the office has been abolished.

Cass L. Kennicott, inventor of water-softening and filtration apparatus, Chicago, Ill., has become associated with Permutit Co., New York City.

H. M. Doughty has been appointed Assistant to the Chief Engineer of the Delaware, Lackawanna & Western R.R. and will have charge of valuation, general drafting office and other special duties.

Charles W. Martin, Assoc. M. Am. Soc. C. E., Engineer, Bridge Division, City of St. Louis, Mo., has resigned to become Secretary of the Woermann Construction Co., Century Building, St. Louis.

Raymond G. Brown, Structural Engineer, Columbus, Ohio, has joined Roy Sims and H. F. Reichard, Architects, under the firm name of Sims, Reichard & Brown, for the general practice of architecture and structural engineering.

Hobart L. Cory and **Francis W. Du Bois** announce the incorporation of Cory & Du Bois, Civil Engineers, Baker, Mont. The new firm will specialize in water-supply, sewerage and sewage-disposal and other municipal work.

M. J. Connerton, formerly Roadmaster of the Cincinnati, New Orleans & Texas Pacific Ry., at Danville, Ky., has been appointed Engineer of Maintenance-of-Way, Southwest district, Southern Ry., Lines West, with headquarters at Chattanooga, Tenn.

P. W. Clancy has been appointed Nebraska representative of the Kansas City office of the Portland Cement Association. He was formerly engaged in municipal work and as Resident Engineer on construction for the Canadian Northern Ry. and Union Pacific Ry.

J. M. Weir, former Assistant Engineer of the Chicago, Rock Island & Pacific Ry. and recently Division Engineer of the Kansas City Southern Ry. at Pittsburg, Kan., has been promoted to be Chief Engineer of the Kansas City Southern, with headquarters at Kansas City, Mo.

William R. D. Hall, Statistician of the Pennsylvania State Highway Department and Editor of the "Pennsylvania Highway News," has resigned to become Manager of the Publicity Bureau of the Philadelphia Chamber of Commerce. He has been with the State Highway Department since 1912.

C. I. Felps has been appointed Field Engineer at the Kansas City office of the Portland Cement Association, with headquarters at Wichita, Kan. He was formerly connected with the Highway Department of Kansas and more recently with the bridge department of the Kansas City Terminal Railway Co.

H. S. Owen, formerly Principal Assistant to the Chief Engineer of Construction of Streets and Sewers, St. Louis, Mo., has accepted the position of Field Engineer at the Kansas City office of the Portland Cement Association. His new work will be confined to eastern Missouri, with headquarters in St. Louis.

R. L. Slocum has been appointed Assistant Superintendent of Mill No. 5 of the Universal Portland Cement Co., at Universal, Penn. He is a graduate of Pennsylvania State College, class of 1905, and has been with the Universal Portland Cement Co. since 1907 and had charge of the construction of the plant at Universal.

William H. Corddy, recently with the W. J. Sherman Co., Toledo, Ohio, and formerly Assistant Engineer, Baltimore Sewerage Commission, has joined the staff of Gannett, Seelye & Fleming, Consulting Engineers, Harrisburg, Penn., as Assistant Engineer on the Mill Creek flood control and Erie sewage-treatment investigation. He is a 1911 graduate of Lehigh University.

E. H. Shipman, M. Am. Soc. C. E., Superintendent of the Lehigh & New England R.R. and Canal Superintendent of the Lehigh Coal and Navigation Co., South Bethlehem, Penn., has been promoted to be Chief Engineer of the Lehigh & New England in charge of engineering, construction and valuation. **C. W. Brown,** Assistant Superintendent, succeeds Mr. Shipman as Superintendent.

John C. Payne, of Trenton, N. J., has been appointed Chief Engineer of the New Jersey Board of Commerce and Navigation, succeeding B. F. Cresson, Jr., M. Am. Soc. C. E., resigned, as noted elsewhere. Mr. Payne has been Assistant Engineer of the Board and for many years was Engineer of the Board of Riparian Commissioners

C. W. Huntington, recently Vice-President and General Manager of the Minneapolis & St. Louis R.R., Minneapolis, Minn., has been elected President of the Virginian Ry., to succeed Raymond Du Puy, resigned, as noted elsewhere. Mr. Huntington is a native of Newark, N. J., and is a former General Superintendent of the Central Railroad of New Jersey. His headquarters will be in New York City.

Raymond Du Puy has resigned as President of the Virginian Ry., effective about May 15. He is a graduate of Georgetown University and began railway work in 1877 as a water boy on the Missouri, Kansas & Texas Ry. For three years he was Assistant Engineer on the Missouri Pacific Ry. For four years he was Chief Engineer and Superintendent of the Tioga Ry. He has been President of the Virginian Ry. for two years.

J. Albert Holmes, M. Am. Soc. C. E., has been appointed Resident Engineer on the so-called Bridgewater developments of the Western Carolina Power Co., for the J. G. White Engineering Corporation, Consulting Engineers of the work. Three large earthfill dams are being constructed by the methods employed on the large earth dam at Somerset, Vt., on which work Mr. Holmes was Resident Engineer. His address is Construction, Burke County, N. C.

Clark R. Mandigo, Assoc. M. Am. Soc. C. E., formerly Assistant City Engineer of Kansas City, Mo., has resigned as Assistant Engineer of the Portland Cement Association to accept the position of Consulting Engineer for the Western Paving Brick Manufacturers Association, Dwight Building, Kansas City, Mo. He will have charge of the Service and Promotional Department for the Association, which operates over most of the territory between the Mississippi River and the Rocky Mountains.

Benjamin F. Wood, M. Am. Inst. E. E., for 16 years Electrical Engineer, Pennsylvania R.R., and for the past three years Vice-President and Chief Engineer of the United Gas and Electric Engineering Corporation, announces the organization of B. F. Wood, Engineers, Inc., Woolworth Building, New York City. The new firm will investigate, design, construct and supervise engineering works in power development, transmission, railroad electrification, electric railway and lighting systems and industrial plants.

Harrison W. Craver, Librarian of the Carnegie Library of Pittsburgh, Penn., has resigned to become Librarian of the United Engineering Societies Library, New York City. He is a graduate in chemistry of Rose Polytechnic Institute and for seven years was head of the Technology Department of the Carnegie Library. He has been Librarian for the past eight years. He is a member of the Engineers Society of Western Pennsylvania, the American Chemical Society, and he is a vice-president of the American Library Association.

B. F. Cresson, Jr., M. Am. Soc. C. E., has resigned as Chief Engineer of the New Jersey State Board of Commerce and Navigation to become Consulting Engineer, with offices at 30 Church St., New York City. For a number of years Mr. Cresson was First Deputy Commissioner of the Department of Docks and Ferries of the City of New York. He will specialize in harbor works, piers, docks, bulkheads, reports on harbor improvement, etc., problems of coast protection and subaqueous tunnel work. He will be retained by the New Jersey Board of Commerce and Navigation as Consulting Engineer.

E. E. Kerwin, recently General Superintendent of the Minneapolis & St. Louis R.R., Minneapolis, Minn., has been elected Vice-President in charge of operation of the Virginian Ry.,

with headquarters at Norfolk, Va. He was born in 1861 at Turner, N. Y., and entered the railway service at 10 years of age as a water boy with a section gang on the New York, Lake Erie & Western R.R. At 22 he became an agent and operator. He was associated with C. W. Huntington, the new President of the Virginian Ry., as Superintendent of the Central R.R. of New Jersey, before they both went to the Minneapolis & St. Louis.

Prof. R. C. Carpenter, M. Am. Soc. C. E., having reached the retiring age at the end of the present college year, will sever his active connection with Cornell University at that time. In accepting his resignation, the Committee on General Administration of the Board of Trustees adopted the following resolution:

Resolved, That the Trustees, in accepting the resignation of Professor Carpenter, express their high appreciation of his services to the university for nearly 30 years. As a pioneer in the field of experimental engineering he is held in the highest esteem by all mechanical engineers, and by his writings in this field he has made an assured place for himself in the annals of his profession. As a teacher and investigator he is affectionately remembered by many generations of students, and his retirement from the Faculty of Sibley College will be viewed with great regret by all his colleagues.

Professor Carpenter expects to maintain his activities in the fields of engineering investigation and research.

Paul P. Whitham, Assoc. M. Am. Soc. C. E., Consulting Engineer, Seattle, Wash., has been selected by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, to make a study of the existing and proposed port and transportation facilities of Russia and the Far East. An itinerary has been decided on which will include Russia, China, Japan, Philippines, French China, Federated Malay States, East Indies, Burma, India and Australia. The investigation will cover ports and their equipment, the railways, canals and river navigation, as well as intelligence communication facilities. The second object of the investigation is to get together reliable information on proposed transportation extensions and improvements, particularly in China and Asiatic Russia. Such information, the Bureau thinks, will be of great value to American investors, engineers, contractors, manufacturers and dealers in port, railway and other transportation equipment. The third object of the proposed study is to supply data and suggestions to American port authorities, engineers and transportation men generally. Mr. Whitham will visit a number of cities in this country before going to the East and expects to confer with shipping men, engineers and contractors, investment bankers, exporters and trade organizations, manufacturers of freight-handling facilities and others who are interested in the investigation. He expects to be abroad about two years.

OBITUARY

Walter Katté, M. Am. Soc. C. E., one of the founders of the Western Society of Engineers, died at his home in New York City, Mar. 4, in his 88th year. He was born and educated in England and came to the United States in 1849. His first work in this country was in railway work in the Middle West. From 1857-1858 he was Resident Engineer of the Pennsylvania State canals, and afterward was engaged in railway construction. During the Civil War he was with the Engineer Corps of the United States Army. He was engineer in charge of erection of the Eads bridge over the Mississippi River at St. Louis, and for 10 years was Engineer and Secretary of the Keystone Bridge Co., Pittsburgh, Penn. He was the first Chief Engineer of the New York Elevated R.R. From 1886 to 1899, when he retired, he was Chief Engineer of the New York Central & Hudson River R.R. He was one of the oldest surviving members of the American Society of Civil Engineers, his membership dating from 1868. He was also a member of the Institution of Civil Engineers of Great Britain.

Ernest L. Ransome, Assoc. Am. Soc. C. E., a pioneer in the reinforced-concrete industry, died Mar. 5 at his home in Plainfield, N. J. He was born in Ipswich, England, 73 years ago, and in 1859 was entered as an apprentice in his father's factory. The concrete industry was then confined largely to the manufacture of artificial stone for ornamental purposes. The father, Frederick Ransome, had patented an artificial stone in 1844. A company was formed in England as the Patent Concrete Stone Co., and in 1870 the process was introduced in America by the Pacific Stone Co., of San Francisco, Calif. Of this company Mr. Ransome was for four years Superintendent. At that time the concrete industry on the coast was slowly developing, with imported portland cement at $9 per bbl. His first patent in this country was during this period, and this patent was for a method of concrete construction designed to prevent the cracking of the concrete over iron beams in concrete arch floor construction. His most famous patent, perhaps, was that granted in 1884 for the now familiar square twisted bar, for use as reinforcing steel. He had long experimented with concrete mixers and in 1884 took out his first mixer patent. His later career is intimately connected with the rise of reinforced concrete for structural purposes, and his name will ever be closely associated with the history of the concrete industry.

ENGINEERING SOCIETIES

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Mar. 5-10. Annual meeting in New York City at McAlpin Hotel. Secy., T. A. Randall, Indianapolis.

CENTRAL ELECTRIC RAILWAY ASSOCIATION.
Mar. 8-9. Annual meeting in Indianapolis. Secy., A. L. Neereamer, Indianapolis.

NEW ENGLAND RAILROAD CLUB.
Mar. 13-17. Annual meeting in Boston. Secy., W. E. Cade, 683 Atlantic Ave., Boston.

VERMONT SOCIETY OF ENGINEERS.
Mar. 14. Annual meeting in Burlington, at Hotel Vermont. Secy., G. A. Reed, Montpelier.

WISCONSIN ELECTRICAL ASSOCIATION.
Mar. 15-16. Convention in Milwaukee. Secy., George Allison, First National Bank Building, Milwaukee.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 20. Annual meeting in Chicago at Coliseum. Secy., C. W. Kelly, Kelly-Derby Co., Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 21-22. Annual meeting in Chicago. Secy., Horace H. Clark, 1325 Edison Building, Chicago.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 20-22. Annual meeting. Congress Hotel, Chicago. Secy., E. H. Fritch, 900 South Michigan Ave., Chicago.

ST. LOUIS RAILWAY CLUB.
Apr. 13. Secy., B. W. Frauenthal, Union Station, St. Louis.

DETROIT ENGINEERING SOCIETY.
Apr. 21. Secy., D. V. Williamson, 46 Grand River Ave., W., Detroit.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
Apr. 26-28. In Dallas. Secy., H. S. Cooper, 405 Slaughter Building, Dallas, Tex.

The Portland Cement Association will hold its spring convention in San Francisco, Apr. 16 to 18, at the Palace Hotel.

The Chattanooga Engineers' Club, organized in August, 1916, has elected the following officers for 1917: President, J. Y. Bayliss; vice-president, J. A. Fairleigh; secretary, A. F. Mellen. The society holds monthly meetings and bimonthly lunch meetings.

The Central Railway Club is holding its twenty-seventh annual dinner on Mar. 8, in Buffalo, at the Hotel Statler. The speakers will be General Goethals and Eugene Chamberlin, with C. E. Denny as toastmaster. The secretary is Harry D. Vought, 95 Liberty St., New York.

The Committee on Engineering Coöperation will hold a third annual conference on Thursday, Mar. 29, in Chicago, at 1735 Monadnock Block. The report of the subcommittee, prepared at a meeting on Nov. 21 in Cleveland, will be presented. On the following day a dinner will be held to which all the engineers in Chicago are invited.

The New York State Association of Architects held its annual convention on Feb. 16 in Syracuse. In the course of the meeting resolutions condemning the location of institutions on the Croton watershed and the location of the Washington power house were adopted. Another resolution approved the proposal made by the National Conference on City Planning that a State Bureau of City Planning be founded. The new officers of the association are: President, Frank H. Quinby; vice-president, Edwin S. Gordon; secretary, Leon Stern, Rochester.

The Ontario Municipal Electric Association held its annual meeting in Toronto on Feb. 15. Sir Adam Beck, chairman of the Ontario Hydro-Electric Power Commission, predicted that in five years the capital invested in the system—at present approximately $41,000,000—would have increased to over $100,000,000, due to the growing demand for power. In the munitions industry, between 400 and 500 plants are operated by hydro-electric power. These plants require 80,000 hp. and employ 40,000 people. Efforts are being made to provide for the requirements of eastern Ontario by securing a large block of power from the Cedar Rapids Power Co., but the permanent solution of the Eastern problem cannot be found until the waterways on the St. Lawrence are deepened. Resolutions were adopted urging the Provincial Government to permit hydro-electric associations to submit by-laws directly to the people where the local councils refused consent to permit municipalities to supply light and power to suburban districts, and to safeguard the rights of municipalities against blanket powers conferred upon power corporations by amend-

ing their charters. Officers were elected as follows: President, Mayor Thomas Church; vice-presidents, W. K. Sanderson and Controller Ellis, of Hamilton; secretary, T. J. Hannigan, Guelph, Ont.

Appliances and Materials

Portable Detachable Boat Motor

A light detachable electric-power unit for propelling small boats has been placed on the market by the Jewel Electric Co., of 112 North Fifth Ave., Chicago. A high-speed vertical motor and transmission shaft are carried by a telescopic supporting tube that is clamped to the stern. A horizontal-shaft propeller is driven through gearing, and the boat is steered by a tiller handle that turns the propeller bracket. Energy is taken from a six-volt storage battery. The outfit sells for from \$89 to \$105, depending on the size of the storage battery desired.

* * *

Huge Single-Roll Crusher

A single-roll rock crusher of the Fairmount type, weighing 225 tons, made by the Allis-Chalmers Manufacturing Co., has been installed at the limestone quarry of the Michigan Alkali Co., at Alpena, Mich. This particular installation is the largest of this type to date. The crushing roll is horizontal, as shown, and is provided with projecting teeth in staggered rows upon the face. The crushing is done against an anvil plate, built up in vertical sections. These sections are hollow steel castings, strung upon a shaft and having the lower or jaw ends carried by a cross-beam which is held by diagonal anchor bolts, as shown. Heavy springs on the ends of these bolts allow the jaw to give slightly under excessive pressure and so prevent breakage. The roll on the Alpena crusher has a cast-steel shell 7½ in. thick, with teeth of manganese steel keyed in slots. This shell is keyed upon a cast-iron spider, which in turn is keyed to a heat-treated steel shaft 20 in. in diameter at the bearings. On the shaft is a 175½-in. gear wheel, driven by a 34-in. pinion on a countershaft carrying a 10-ft. belt pulley with 37-in. face. This is belted to a 250-hp. motor, the distance between motor shaft and pinion shaft being about 18 ft. The motor runs at 580 r.p.m., the pinion at 120 r.p.m. and the crushing roll at 23 r.p.m. The machine is mounted on a massive concrete base.

The main part of the hopper is of cast steel, 7x12 ft. at the top. Above this is a structural-steel hopper into which the rock is dumped from standard-gage quarry cars, which are of 12 to 14 tons capacity. Rocks 5x7 ft. can be handled. The crusher is adjusted for a 7-in. product and delivers about 7000 tons of broken stone per 10-hr. shift.

The two principal points in which the Fairmount crusher differs from earlier roll-type crushers are (1) the use of an anvil gradually approaching and extending under the roll, and (2) the use of a roll having part of the knobs or studs higher than the regular ones. The first feature increases the size of the opening where the stone is crushed against the anvil plate. In regard to the large or slugger knobs, it has been found that with knobs of uniform height the crusher is not suitable for breaking large stone. This was discovered on the original machine. It was verified recently, to settle a dispute, by fitting a roll with knobs of uniform size. This would do very good work on small pieces of stone which could be gripped between the roll and the anvil, but large blocks of stone were not crushed at all, and it was necessary to shut down the crusher and lift them out.

The first crushers of this type were installed in 1911 at the plant of the Casparis Stone Co., at Fairmount, Ill., where two of the machines were started in 1912. It is stated that single-roll crushers had been used prior to that time for crushing the smaller size of stone loaded by hand. They were not suitable for crushing the large-sized rock loaded by steam-shovels, however, as the opening between the roll and the concave breaker plate was not sufficient to allow large pieces of stone to be gripped, and no provision was made for sledging the stone on top of the roll.

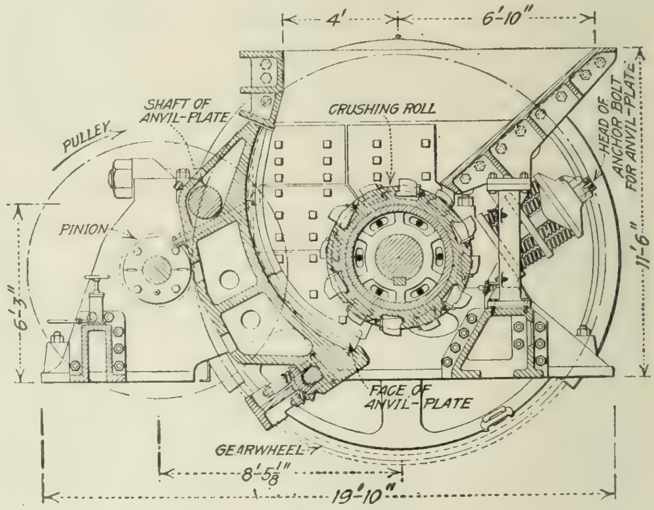
The crusher is placed in a building on the floor of the quarry, the center line of the roll being about 45 ft. below the ground. A cable incline with two balanced 8-ton skips delivers the stone to a rotary screen above an elevated storage bin on the surface. The paved chute from the crusher to the loading pit of the skips is closed by motor-operated sliding doors parallel with the incline. These are operated automatically by means of tripping levers on the skips.

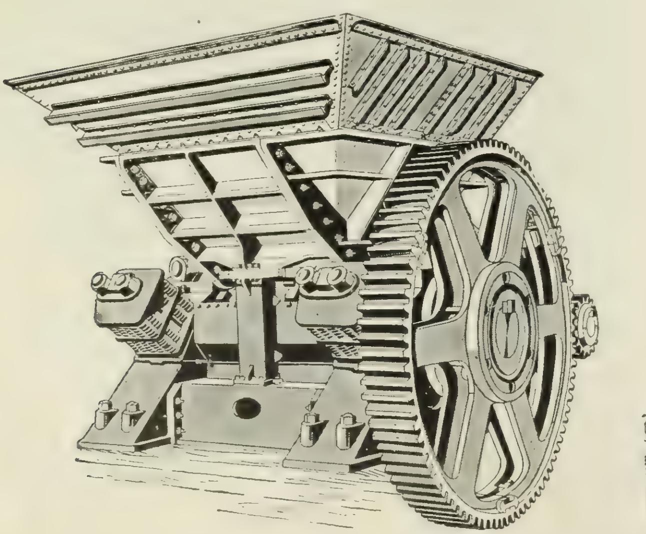
This machine was designed under the direction of R. C. Newhouse, engineer of the crushing and cement machinery department of the Allis-Chalmers company.

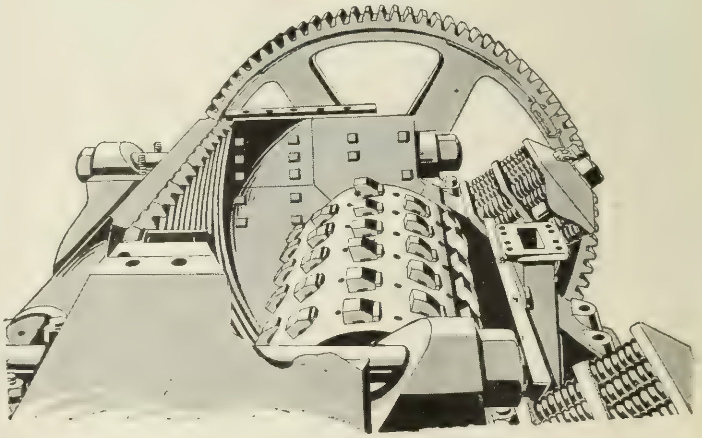
* * *

Liquid Boiler-Scale Remover

A liquid intended to be injected into steam boilers to loosen adherent scale is being introduced by the Perolin Railway Service Co., of St. Louis, Mo. This material, bearing the trade name "Perolin," is not a boiler compound, but is a "viscous mineral" that penetrates cracks in the scale and later expands, forcing off the coating. It is claimed that the material, once on the plates, conducts heat, prevents adhesion of precipitated solids and prevents corrosion.







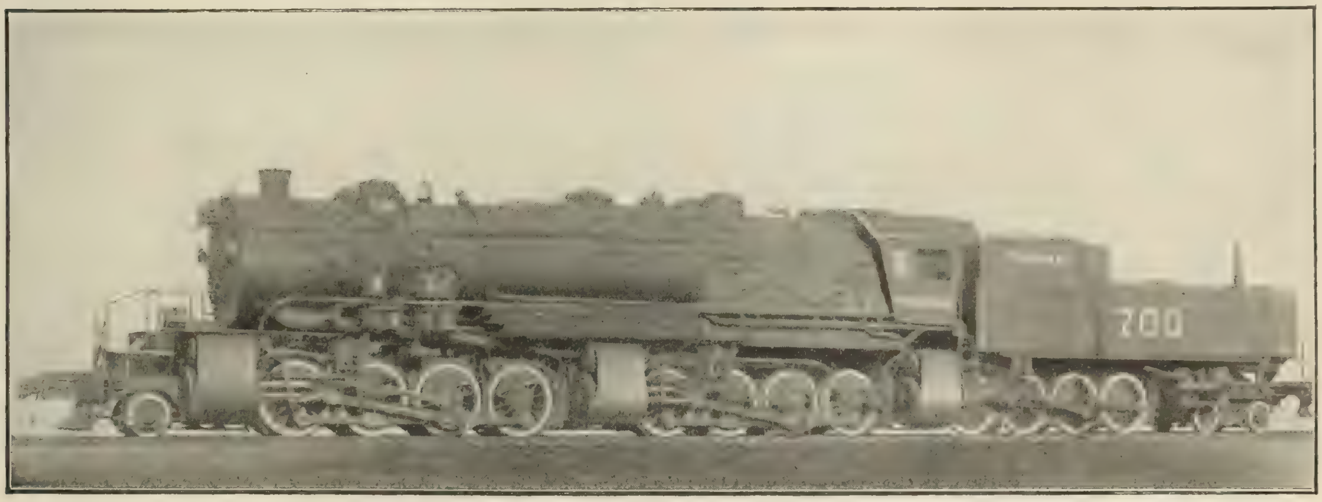
TWO VIEWS AND SECTION OF ALPENA ROLLER ROCK CRUSHER

Engineering News

VOLUME 77 MARCH 15, 1917 NUMBER 11

Virginian Railway Has World's Greatest Steam Locomotive

A new record in size and capacity of railway locomotives has been made by the triple articulated 422-ton freight locomotive patented by George Henderson and built by the Baldwin Locomotive Works for the Virginian Ry. As shown in the accompanying illustrations, it has a 2-8-8-8-4 wheel arrangement, and in its general features is similar to the slightly smaller triple locomotive built for the Erie R.R. (as described in *Engineering News*, May 7, 1914). The maximum tractive effort of the Virginian unit is 166,300 lb. It has a height limit of 16 ft. 10 in. and a width limit of 12 ft. at a height of 2 ft. 3 in. above the rail. The center line of the boiler is 10 ft. 9 in. above the rail. The rigid wheel base is 15 ft. 3 in. and the total wheel base 91 ft. 3 in. The Erie locomotives, it will be recalled, had a total weight of 422.5 tons, a rigid wheel base of 16 ft. 6 in., and a total wheel base of 90 ft. The maximum tractive effort was 160,000 lb.



THE LARGEST STEAM LOCOMOTIVE IN THE WORLD
Triple compound locomotive built by the Baldwin Locomotive Works for the Virginian Ry.

The Virginian locomotive, like its prototype, has a third set of cylinders and driving wheels under the locomotive tender, all cylinders of the same size with the two center cylinders taking high-pressure steam and discharging to the end pair of cylinders working on lower pressure, a huge superheater, a feed-water heater on the tender, etc.

Flanged tires are used throughout, the lateral play between flanges and rails being $\frac{1}{8}$ in. on the front and back drivers of each group, and $\frac{5}{8}$ in. for the main and intermediate pairs. Since the railroad has no turntable capable of taking this unit, it is turned on Ys, laid out with a curvature of 18°. The three groups of driving wheels carry approximately an equal load (60,500 lb. per axle). The weight of the overhang on the tender is carried by a four-wheeled constant-resistance engine truck. This has a total swing of 13¼ in. and carries a load equal to that of an express passenger locomotive of 30 years ago—82,000 lb.

The frames are vanadium-steel castings 6 in. wide. The radius bars at the two articulated connections are attached to horizontal transverse pins, fitted with case hardened, spherical bushings to provide flexibility in both vertical and horizontal planes and to prevent binding of the hinge pins when passing over sudden changes in grade or poorly surfaced tracks. The structural details show several unusual steel castings. For instance, the weight bearers supporting the forward part of the boiler and the three guide bearers are all bolted to both upper and lower frame rails and form effective transverse frame braces. The front bumper beam and deck plate are combined in a large steel casting, which houses the draft gear.

The boiler is of the wagon-top type and has a maximum diameter (third ring) of 110 in. Longitudinal seams are all placed on the top center line. The dome ring seam is welded for its entire length, and the seams on the first and second rings are welded at the ends. The circumferential seams between the second and third rings, and between the third ring and the throat and outside firebox sheets, are triple riveted. The back tube sheet is straight and the tubes are 25 ft. long. The furnace (Gaines type for soft coal) has its arch supported on five tubes. The firebox is above the middle group of driving wheels and the available space for the throat is restricted.

Throat depth has been increased by depressing the front bar of the mud ring between wheels. Flexible stay bolts are used for the throat and back of the firebox, and in the breakage zones of the sides. Four rows of expansion stays support the forward end of the crown. The mud ring is supported on vertical plates front and back, and at one intermediate point where the load is transferred to the plate through a transverse cast-steel brace, which supports the longitudinal grate bearers. The ash pan, in spite of limited space, has two large hoppers with cast-steel bottoms and drop doors. A longitudinal duct runs through the pan to carry the back receiver pipe and reach rod. Air is admitted at the front of each hopper and near the top of the duct at each side, as well as under the mud ring.

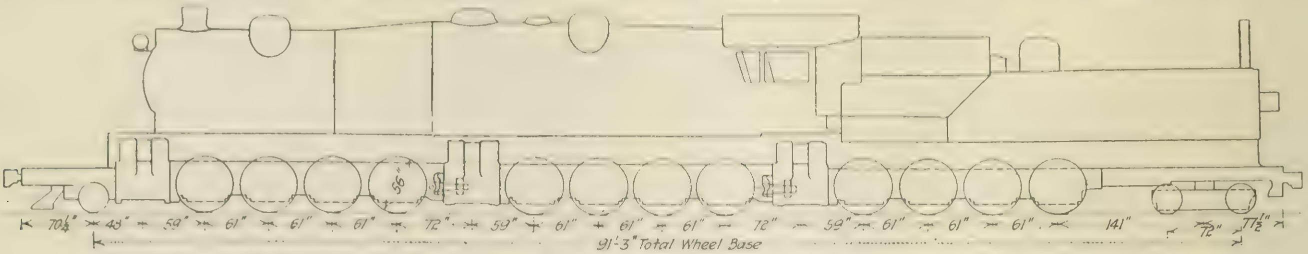
The superheater has 65 elements with 2059 sq.ft. of surface. The header is of cast iron in one piece. The superheater steam pipes leading back to the high-pressure cylinders have slip joints. The right-hand pipe has a connection through a cast-steel elbow with the starting valve (Simplex type) located in the high-pressure cylinder saddle. This saddle is in two pieces, the upper being riveted to the boiler shell. The lower piece is cored out for the intercepting valve and pipe connections.

All six cylinders were cast in the same pattern and are of vanadium iron, designed so that ¾-in. bushings can be subsequently used if desired. The pistons have dished heads of forged steel with cast-iron bull rings, held in place by electrically welded retaining rings. The piston rods are of nickel-chromium steel and are without extensions. The cross-head bodies (Laird type) are of vanadium cast steel and are made as light as consistent with demands for strength. The main crank pins are of nickel-chromium steel, and are hollow bored. The main and side rods and main driving axles are of chrome-vanadium, heat-treated steel. Vanadium steel is used for the driving tires and springs.

The valve motions are of the Baker type controlled by a Ragonnet power-reverse mechanism. When working compound the high-pressure cylinders exhaust into a common chamber, which communicates with the front and back receiver pipe. During starting, an interceptor valve admits live steam to front and back receiver pipes, as well as to the high-pressure cylinders, and the high-pressure exhaust is conveyed to the smoke box through a separate pipe which terminates in an annular nozzle surrounding the main nozzle. The intercepting valve is arranged so that steam can be admitted through a pipe connection from the cab and the locomotive worked on single expansion at any time. When drifting, saturated steam can be admitted to the high-pressure cylinders through a special pipe connected with a valve in the cab.

The exhaust steam from the rear cylinders passes through a feed-water heater placed under the tank on the tender. This heater consists of a long drum 22 in. in diameter, traversed by 31 tubes of 2¼-in. diameter and provides 137 sq.ft. of heating surface. The exhaust steam passing through the feed-water heater is released through a small stack at the rear of the tender. The exhaust from the forward cylinders is led to the main nozzle in the smoke box and used for creating draft.

The feed water is handled by a piston pump working between the tank and heater, and placed under the tank and back of the rear drivers. This requires a flexible connection in the steam line leading to the pump, but the arrangement is justified by the greater reliability of the pump working on cold water. The locomotive has two injectors for emergency use.



SKELETON ELEVATION OF TRIPLE COMPOUND LOCOMOTIVE, SHOWING WHEEL SPACING

The cab is roomy and permits convenient arrangement of fittings. The front wall is sloped to follow the inclination of the back head and give ready access to stay bolts. The equipment includes a pyrometer and a low-water alarm. The use of power reverse in simplifying the arrangement of the cab fittings is most apparent on a locomotive of this size.

The sanding arrangements on this locomotive are interesting. Four sand-boxes are placed right and left of the boiler, two for the forward group of wheels and two for the middle group. The tender tank carries a sand-box for the rear group, with the discharge pipes running through the tank in 4½-in. vertical pipes. In connection with the sanders (Graham-White type) are rail washers at each end of the locomotive. A special valve in the cab controls the sand and washing water simultaneously. When the valve handle is turned in one direction, sand is delivered under the front drivers of each group, and water is discharged through the washing pipes at the rear; if the handle is turned in the opposite direction, sand is delivered under the rear drivers of each group and water is discharged through the front washing pipes.

PRINCIPAL DATA OF 2-8-8-8-4 TRIPLE LOCOMOTIVE, VIRGINIAN RY.

General	
Gage	4 ft. 8½ in.
Cylinders	34x32 in.
Valves (piston)	14 in. diam.
Boiler	
Type	Wagon-top
Diameter	100 in.
Thickness of sheets	$\frac{31}{32}$ in., $1\frac{1}{32}$ in., $1\frac{1}{16}$ in.
Working pressure	215 lb.
Fuel	Soft coal
Staying	Radial
Fire Box	
Length	188 in.
Width	108¼ in.
Depth, front	93⅝ in.
Depth, back	75⅞ in.
Thickness of sheets, sides	⅜ in.
Thickness of sheets, back	⅜ in.
Thickness of sheets, crown	⅜ in.
Thickness of sheets, tube	⅝ in.
Grate, length	144 in.
Water Space	
Front	5½ in.
Sides	5 in.
Back	5 in.
Tubes	
Diameter	5½ and 2¼ in.
Thickness	5½ in., No. 9 W. G.
	2¼ in. No. 11 W. G.
Number	5½ in., 65; 2¼ in., 365
Length	25 ft.

Heating Surface	
Fire box	359 sq. ft.
Tubes	7689 sq. ft.
Firebrick tubes	72 sq. ft.
Total	8120 sq. ft.
Superheater	2059 sq. ft.
Grate area	108.2 sq. ft.
Driving Wheels	
Diameter, outside	56 in.
Diameter, center	49 in.
Journals	11x13 in.
Truck Wheels	
Diameter, front	30 in.
Journals	6½x14 in.
Diameter, back	30 in.
Journals	6½x14 in.
Wheel Base	
Driving	67 ft. 7 in.
Rigid	15 ft. 3 in.
Total	91 ft. 3 in.
Weight, Estimated	
On driving wheels	726,000 lb.
On axle	60,500 lb.
On truck, front	36,000 lb.
On truck, back	82,000 lb.
Total	844,000 lb.
Tank capacity,	13,000 U. S. gal.
Fuel capacity	12 tons
Tractive force	166,300 lb.

Rail-Chairs and Tie-Plates on the Northern Pacific Ry.

Experiments with large baseplates, or rail-chairs, secured to the ties by through-bolts are being made on a test section of main track on the Northern Pacific Ry. These experiments form part of a series of tests made in conjunction with the Forest Service of the United States Department of Agriculture, which began in 1905-07 with the seasoning and treating of ties of Western species of timber. These ties were afterward put in two test tracks to determine their relative durability with cut-spikes and screw-spikes and with several types of tie-plates.

Coöperative experiments with the rail-chairs having bolt fastenings, in comparison with tie-plates held by cut-spikes, were begun in 1915, the screw-spikes used in the test tracks not having proved very satisfactory. For this purpose a stretch of about 3000 ft. of track near Thompson Falls, Mont., was laid with wood ties of different species, some of which were equipped with the malleable-iron rail-chairs secured by bolts through the ties, while others had the railway company's standard tie-plates and cut-spikes. The length of track included curves and carried heavy traffic. It had 90-lb. 33-ft. rails, 19 ties per rail, with about 12 in. of sandy gravel ballast (of inferior quality) on a well-drained roadbed.

Two types of rail-chairs were tried, one of which (made of malleable iron) is shown in the accompanying drawing. The form used on intermediate ties (shown at the left) is 12¼ x 7 in., with hollow lugs on the bottom which enter sockets cut in the ties. The joint chair is of similar construction, 16½ x 7 in., weighing about 15 lb., but is secured to the tie by two screw-spikes independent of the bolts that secure the rails. Each rail-chair has two bolts. The bolt has a short square shank and button head on the lower end (with a washer between the head and the tie), and its threaded end engages a threaded sleeve having a nut head.

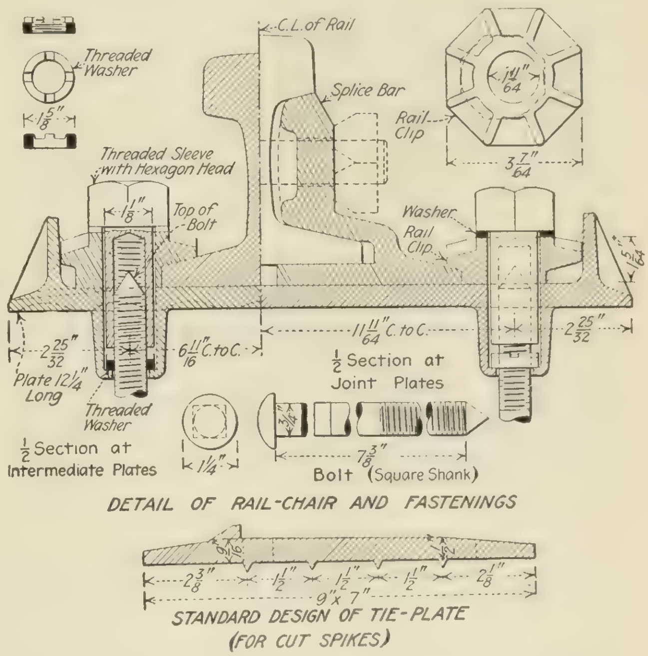
This sleeve passes through an eccentric clamp that grips the rail base. The eccentric construction allows for varying the gage, using rails with different widths of base, and taking up the wear of the rail-head, by shifting the position of the clamp without removing the bolt. Thus such adjustments may be made with less damage to the ties than where spikes have to be drawn and redriven. The rear of the clamp has a bearing against a rib on the chair. A threaded washer in the bottom of the pocket holds the bolt in place until the sleeve is applied or when the sleeve is removed. A claim made for this fastening by the maker is that it will allow for shimming up the track.

The other form of rail-chair (made either of rolled steel or malleable iron) has a flat plate without bottom lugs and is held in place by two screw-spikes independent of the bolts that secure the rails. The joint chair used with this was the same as described above. In both cases the rails were spliced with the continuous joint, as shown, the flanges of which were not slotted. Both forms of rail-chairs were made by the Vignoles Rail-Chair Co., of Chicago (represented by A. G. Liebmann, 7433 Emerald Ave., Chicago).

The standard rolled-steel tie-plates of the Northern Pacific Ry., used on other sections of the test track, are 7 x 9 in., ½ to $\frac{9}{16}$ in. thick under the rail and with sharp ribs on the bottom. This also is shown on the accompanying drawing. The upper surface has the rail seat inclined slightly inward (about $\frac{1}{16}$ in. in 5 in.) and has a shoulder along the outer side. Ordinary $\frac{9}{16}$-in. cut- or drive-spikes are used (two to each rail). The rail joints are spliced with angle bars having the flanges slotted for the spikes, to hold the track from creeping.

An inspection of this track was made after seven months' service, including the severe winter of 1915-16. During this period the ballast had been frozen for a considerable time, and the traffic was exceptionally heavy. It was found that both types of bolted rail-chairs prevented creeping of the rails. Where tie-plates and cut-spikes were used, this creeping occurred, as shown by the skewing of ties at joints (the track being laid with broken joints). There was also a tendency in the latter case for the ties to bunch near the joints after only seven months' service.

No work had been done on the ties equipped with the rail-chairs since they were laid, and the track was still in good condition as to line, surface and gage.



RAIL-CHAIRS WITH THROUGH-BOLT FASTENINGS, AND TIE-PLATES WITH SPIKES; NORTHERN PACIFIC RY.

It was found necessary to tap down all the cut-spikes about the middle of March and again during May, and a few of the joints had to be tamped up, due to the shifting of the ballast.

It was noticed that trains make less noise and ride more easily in passing over the track laid with bolted rail-chairs than over that laid with the tie-plates held by common spikes. This is due probably to the fact that with the former the chair, rail and ties are held together more firmly, without any play. At the time of inspection this track had not been in place long enough to show any difference in wear of ties of the various species or between those with rail-chairs and tie-plates.

The track is still in service and will be inspected from time to time. Information as to the track construction and tests has been furnished by P. R. Hicks, Engineer in the United States Forest Products Laboratory (at Madison, Wis.), and L. Yager, Acting Engineer of Maintenance-of-Way, Northern Pacific Railway.

Deep Dredging Piers and Multiple Pneumatic Pier on the Thames Bridge

SYNOPSIS—To found a heavy four-track bridge in over 100 ft. of soft clay or mud, three piers are being sunk to gravel by open dredging, two going 140 ft. below water. Interesting crib framing. Jet pipes are used to help in sinking. The cribs are launched and floated to the site. A multiple-caisson pneumatic foundation to rest on sloping rock will be built for the fourth pier.

Open-well dredging is the method used for constructing the chief part of an unusually difficult and costly bridge foundation—that for the new Thames River bridge of the New York, New Haven & Hartford R.R., at New London, Conn. The two channel piers, supporting a trunnion bascule bridge and adjoining 330-ft. fixed spans,

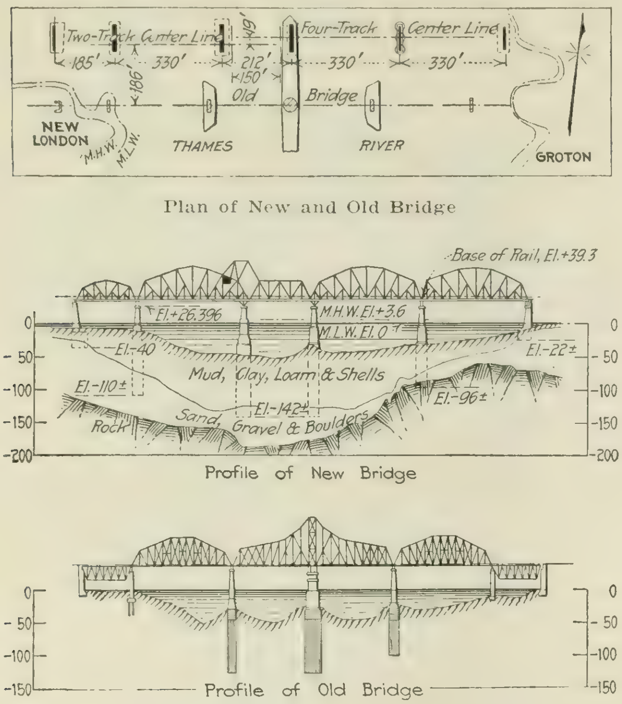


FIG. 1. GENERAL LAYOUT OF THAMES RIVER BRIDGE AT NEW LONDON, N. Y., N. H. & H. R.R.

will go down to 140 ft. below mean tide, while the west pier goes down to 96 ft. (see profile, Fig. 1). However, the pneumatic-caisson process will be used for one of the four piers, which is the east pier.

The subsoil is mud or soft clay for 50 to 100 ft. depth, water being 20 to 50 ft. deep, and below the mud is firm gravel to support the deep piers. Rock is found at the east pier at practicable depths, permitting pneumatic work without exceeding air pressures in which men can work. The unusual feature here is that the rock shelves down in the upstream direction rather abruptly; and to avoid sinking the caisson cutting edge into rock or, on the other hand, resting one corner on rock and then undercutting at the opposite edge for quite a depth in sheeted excavation, three separate caissons will be used, 35 ft. c. to c., each 22 ft. in diameter, supporting a single pier shaft (Fig. 3).

Work on the dredging piers is well under way. Construction of the pneumatic pier has not yet begun at the site. Holbrook, Cabot & Rollins, of Boston, are doing the work.

The old bridge, about 200 ft. downstream of the new location, has its piers resting on piles. It was not desired to use piles for the new bridge, however, as the soft river-bottom loam or clay would not give adequate lateral support to a pile cluster in the degree requisite for the bridge. It is important to observe that the new bridge is designed for ultimate four tracks and the substructure will be built for the final width, though only a two-track superstructure will be erected for the present. Four-track design required not only unusually large piers, but also made permanent and undoubted stability a specially important consideration. In fixing on the foundation design many other structures were studied and all available data given due consideration, as it was recognized that the problem called for high engineering skill and judgment to produce a foundation that should be at the same time stable and economical. The design adopted is the plan of the New Haven's engineering department, primarily of Edward Gagel, chief engineer.

The pier supporting the bascule trunnion is 42 x 99 ft. in the lower, or crib, portion and will go down 140 ft. below low water. The sinking is well begun, the caisson cutting edge being at the present time at about 100 ft. below water. The other deep pier, Pier 3, on the east side of the channel, is 30 x 94 ft. in plan and goes down to substantially the same elevation, —140 ft. The west pier, of the same size, 30 x 94, goes down 96 ft. and has already been landed and concreted. Interesting details of construction and special methods of framing and launching were employed in the dredging piers.

Concrete Cutting Edges Under Timber Cribs with Vertical Tie-Bars

The cribs for the three dredging piers are of practically identical design (see Fig. 2). Each has eight rectangular wells about 10 x 12 ft. in the well shaft, flaring out in the lower 13 ft. of height to the full one-eighth of the pier-base area $15 \times 23\frac{1}{2}$ ft. for Piers 1 and 3; $20\frac{1}{2} \times 24\frac{3}{4}$ ft. for Pier 2). The cell spaces between the wells therefore taper sharply inward at the bottom to the cutting edge, around the outside of the crib and between the wells. This cutting edge is a monolithic mass of reinforced concrete, to a height of 13 ft.; it is shod with a steel plate that extends 3 ft. up on either side and is anchored by a framework of angles enveloping the cutting-edge concrete.

The crib framing begins at the 13-ft. level. It consists of solid courses of 12 x 12 timbers making up the outer walls and the walls of the dredging wells. As sketched by the corner detail, Fig. 8, the wall timbers and the necessary tying between walls are provided for by an arrangement of three successive courses, one with continuous longitudinals (and in the transverse walls filler pieces), the next with continuous transverse timbers (and in the longitudinal walls filler pieces) and the third composed wholly of filler pieces in the walls in both directions. The courses are driftbolted together. There

are no vertical rib timbers, but instead, at 3-ft. spacing, vertical steel tie-straps about $1 \times \frac{1}{2}$ in., of which every third one runs up to the top, while the other two stop at lower points of the crib. These straps are spiked to every course. The concrete filling placed in the cell spaces during the sinking is bonded vertically by $1\frac{1}{4}$-in. twisted reinforcing bars. The outside of the outer walls and the inside of each dredging well are made tight by a sheathing of 3-in. plank with calked joints. Vertical planking was used for the lower 16 ft. and above this horizontal planking, the latter being more convenient to place.

These piers are fitted with a new piece of equipment intended to facilitate sinking through the clay or mud—namely, jetting pipes leading to the cutting edges, embedded in the cutting-edge concrete and led up through the cell spaces to suitable water headers at the top. The discharge nozzles on these pipes point downward and away from the cutting edge in the dredging wells and upward and away from the cutting edge on the outside. The pipes are spaced about 8 ft. apart. Those on the outside face of the outer cutting edge, which point upward, are intended for reducing the skin friction of the pier, if sinking should prove difficult.

The timber work of the crib becomes embedded in the concrete forming the pier body, composed of that which is filled into the cell spaces during sinking and the subsequent filling of the dredging wells when the pier is bottomed. This timbering is built up only to the designed river-bottom height, above which level a plank-wall cofferdam will be placed as protection for the work of concreting the shaft, or upper, portion of the pier.

Crib Built on False Bottom on Shore and Launched

The lower portion of the pier crib is framed on shore on a ship railway, the cutting edge is concreted, and the structure is then launched on a false bottom, floated to its site and sunk, after being built up high enough to project above the water when embedded in the bottom. The pier cribs for Piers 1, 2 and 3 have already been built and launched; the first one has been dredged down to final level, and the pier is practically completed.

The ship railway, located about a mile north of the bridge site, has a sliding platform on its ways. On

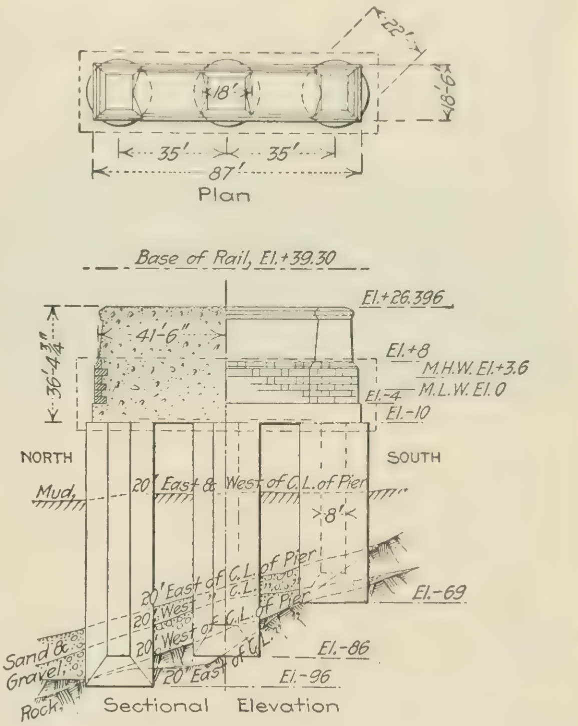


FIG. 3. MULTIPLE-CAISSON PIER (PIER 4) OF NEW THAMES RIVER BRIDGE

this platform, blocked up over the keel blocks, was laid a false bottom of 4-in. timber, calked water-tight, on which the crib structure was erected. Longitudinal 12x12 timbers laid on 4-in. nailing strips on the floor furnished bearings for the cutting-edge steel. Reinforcing and forms for the cutting edge were then built up

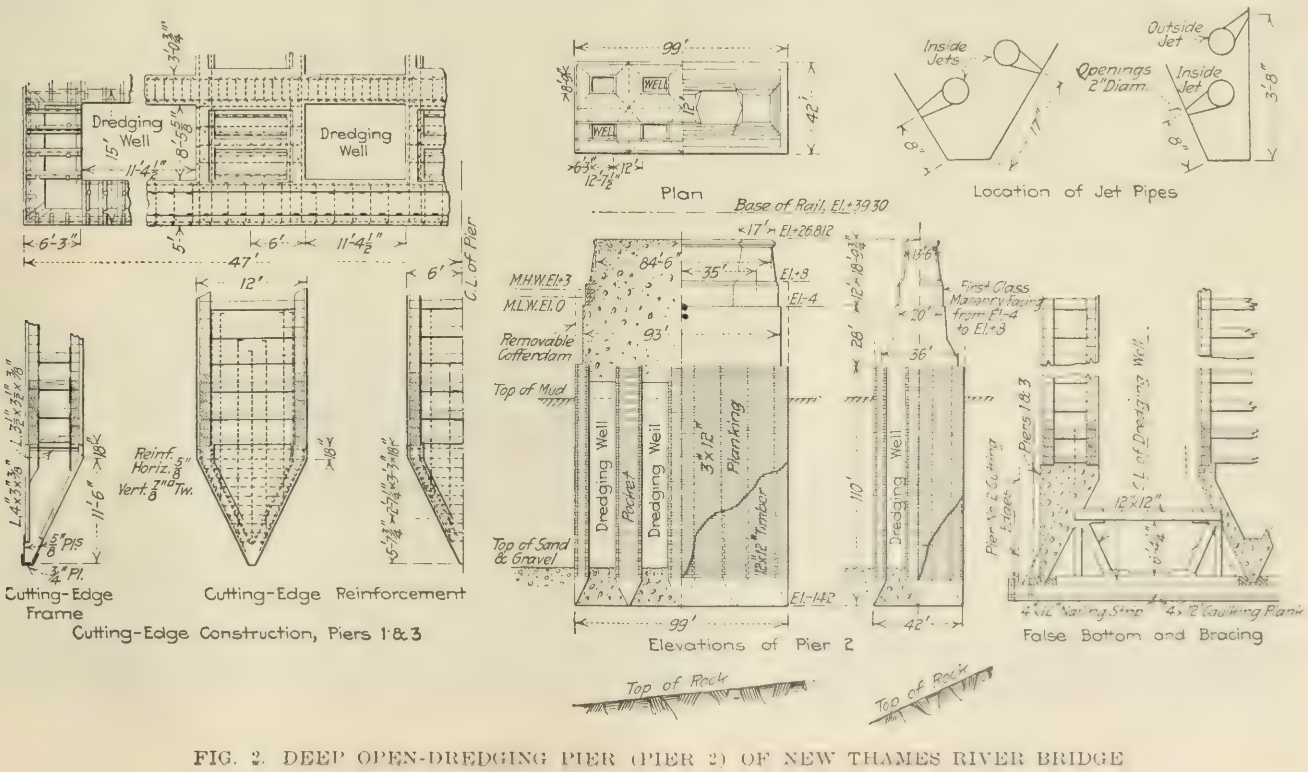
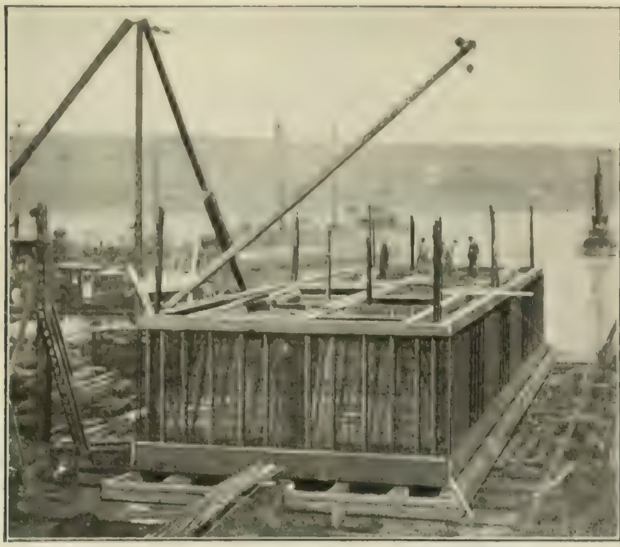
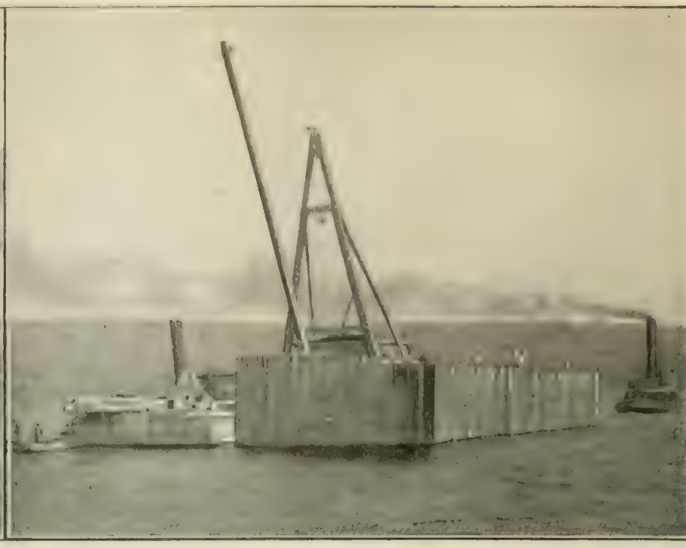


FIG. 2. DEEP OPEN-DREDGING PIER (PIER 2) OF NEW THAMES RIVER BRIDGE

FIGS. 4 AND 5. ONE OF THE THAMES RIVER BRIDGE PIER CRIBS READY FOR CONCRETING THE CUTTING EDGE, AND WHILE FLOATING TO THE SITE

and several courses of the crib timbering set before concrete was poured. The jetting pipes were of course placed at the same time, as were also the straps embedded in the concrete and extending up to tie the timberwork together.

The 13-ft. height of concrete was placed in several successive lifts. A mixing plant on the wharf alongside, served by a stiff-leg derrick, supplied all concrete for this work by way of bottom-gate buckets handled by the derrick.

The launching floor, or false floor, is intended to make early launching possible and must stay in place and remain water-tight until the floating crib has been built up 15 or 20 ft. higher. The water pressure against the floor—nearly 1 ton per sq.ft. at the initial draft—is taken by three trusses of inverted queen-post construction built across the bottom of each well, supporting the 4-in. planking on lines about 4 ft. apart. Tightness between floor and crib is secured by a calking timber around the outer edge as shown in Fig. 2.

The different wells are not isolated from each other, since the cutting edges are about 18 in. above the floor; nevertheless, the structure trims well. Complete stability calculations were made for various conditions of the structure, so that the margin of stability and the trim, etc., were known in advance.

The crib was built up to 22-ft. height for launching. The launching floor reduced the draft at launching to about 17 ft. After building up the crib by an additional 16-ft. section, the floor could be removed, and the draft then was about 35 ft. To place the pier crib on the bottom ready for dredging operations to begin, it was necessary to remove the floor and then gradually load the structure until it rested on the river bottom. The removal of the false bottom is done by filling the dredging wells with water to equalize the pressure on the false bottom, dumping a sufficient quantity of mud or sand into the dredging wells to overcome the flotation of the timber in the false bottom itself, then pumping a slight amount of additional head into the dredging wells, which forces the calking seam between the crib and the false bottom.

In the removal of the false bottom from Pier 1, trouble was experienced at the corners of the dredging wells on account of the heavy pressure, which sprung the corners of the wells, allowing sufficient leakage to sink the crib. The latter was readily raised by floating over it a portion of the final upper caisson, clamping this to the sunken structure by long rods, calking the joint and pumping out. The trouble was then remedied by introducing a system of additional bracing in the lower section, between the outer walls and the dredging-well walls.

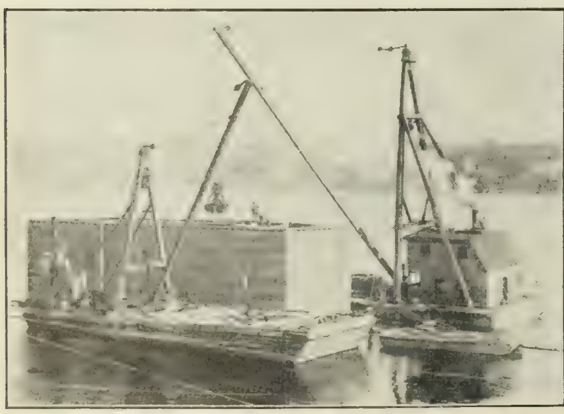


FIG. 6. DREDGING DOWN PIER 1

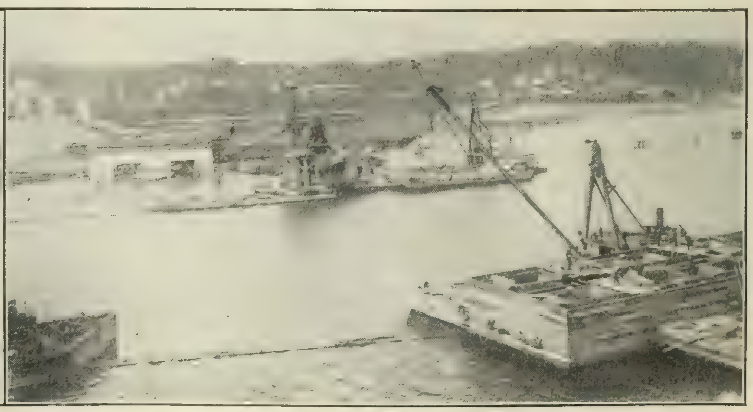


FIG. 7. VIEW FROM PIER 2 TO WEST ABUTMENT; PIER 1 COFFERDAM BETWEEN

Dredging was done by orange-peel, handled by a derrick on a derrick scow alongside the pier. The order and frequency of dredging operations were wholly at the direction of the engineer's inspector on the pier, but every effort was made to carry on the work in such a way as to minimize the number of moves of the derrick scow. Neither the loam or clay (the lower strata of the soft ground appeared as more or less typical clay) nor the gravel below gave any trouble in dredging.

Dredging the Piers Down

The jetting pipes on the inside of the cutting edges were used more or less throughout the work; they are found to have considerable value in loosening the material. The jetting pipes on the outside of the caisson, however, proved to have little effect in loosening the structure from the surrounding mud (lubricating effect), but on the contrary the water seemed to flow back under the cutting edge into the inside, against the full water head.

The dredging was facilitated by an extra jet pipe, handled from a lighter alongside. This consisted of a 4-in. pipe about 106 ft. long, with a 2-in. jetting nozzle on the lower end together with a rosette of four or five

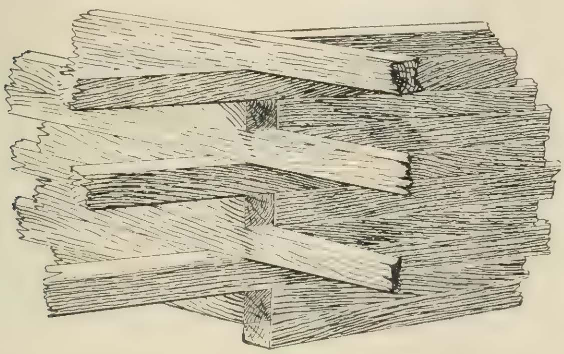


FIG. 8. SKETCH OF PIER-CRIB FRAMING SHOWN AT CORNER OF A WELL

$\frac{3}{8}$-in. holes, the 2-in. nozzle pointing straight down and the small holes discharging in a horizontal plane. This pipe was connected to the pump by a flexible connection and could be moved at will, from well to well, or shifted about in any well. This proved the most effective method of loosening the material to be excavated from the wells.

No difficulty was found in keeping the piers vertical and in position. Levels were read, and at the same time center-line observations made, twice a day. The dredging was so controlled as to correct any error of level or, when necessary, produce a slant in one direction or another to force the pier over into line if it was found to be off line slightly.

Some boulders have been found in the upper portion of the gravel stratum and the sand directly above it. They give a certain amount of trouble at times by tendency to collect, the buckets dredging out mainly the smaller stuff until more or less of a layer or pocket of larger stone has formed, which interferes with digging.

The crib for Pier 1 was set Sept. 6, 1916, in the mud of the river bottom, with the cutting edge at El. — 43, and was bottomed at El. — 96 on Nov. 23, a period of 78 days being taken for the building up and sinking. This includes sinking the caisson 53 ft., placing approximately 280 M b.m. of timber (exclusive of the temporary cofferdam sides), and placing about 3000 cu.yd. of concrete in the cells. Very little sinking took place except as a result of dredging; the actual dredging was in operation about seventy-four 10-hour shifts. The addition of concrete or timber produced practically no sinking. The average sinking per shift of dredging was 0.6 ft.

After the pier was bottomed, the dredging wells were sealed with concrete deposited by a tremie of 15-in. pipe, the tremie at the beginning of the operation being 106 ft. long. Each well was sealed to a depth of 60 to 80 ft. After all wells had been sealed, the temporary cofferdam and remaining portion of the well section were pumped out and the pier shaft completed.

A facing course of granite masonry is carried around the pier from El. — 4 to El. + 8, covering the tidal range. The joints in this masonry are not pointed with cement mortar; the pointing is done by calking the joint for a depth of about 1 in. with lead wool.

At the present time Pier 2 is in progress of sinking. The permanent timber has all been placed and two-thirds of the concrete in cells has been placed. The progress per 10-hour shift of dredging, to date, has been at the rate of 1.5 ft. The cutting edge is now below El. — 100. The crib of Pier 3 is set in position, and over half of the permanent timber is in place. Dredging and concreting in the cells have not yet been commenced. The three pneumatic cylinders to constitute Pier 4 are under construction at the shipyard.

The work is in general charge of I. D. Waterman, construction engineer, New York, New Haven & Hartford R.R., New Haven, Conn., under Edward Gagel, Chief Engineer, and is supervised by P. B. Spencer, Division Engineer of construction, New London. Holbrook, Cabot & Rollins, of Boston, are the contractors and are represented on the work by L. S. White, Superintendent.

Excessive Water Waste in Grinnell, Iowa, is pointed out in a report submitted to the City Council by F. H. Crosby, City Manager. For the six months ending with October, 1916, the average quantity of water pumped monthly was 10,498,875 gal., of which 7,332,209 gal. were not accounted for. This is all the more noticeable since there are only about 80 flat-rate consumers in the city. There is reason to believe that a considerable amount of the unaccounted-for water escapes through so-called "¾-in. mains, practically all old and badly rusted." The exact length of such pipe is unknown, but is "fully 20,000 ft.," much of which, Mr. Crosby says, is "doubtless leaking badly." At the time of Mr. Crosby's report an investigation was being made of the possible waste of water through automatic sewer flush tanks, and instructions had been given to use the detectorphone in a house-to-house inspection.

Salt in the Streams in the oil districts of southern Kansas and northern Oklahoma is causing much complaint from cities utilizing the streams for domestic water-supply. Many of the oil and gas wells in this district discharge large quantities of salt water at more or less regular intervals, and practically all of the abandoned wells are flowing salt wells. The difficulty is of course accentuated at times of low flow in the stream, and ordinarily at times of high flow is scarcely noticeable. The water-supply at Sedan, Kan., on the Caney River, with an ordinary chlorine content of 10 to 25 p.p.m., reached 550 p.p.m. in October, 1913, and, according to the city officials, at times is even higher than that. In October, 1916, it reached 505 p.p.m. The supply at Caney and Cedarvale, Kan., on the same river, has approximately the same range of chlorine content. The new oil field on the drainage area of the Walnut River, which is utilized by the cities of Augusta, Douglass and Winfield, Kan., is apparently about to produce the same difficulty. Complaint has reached the Kansas State Board of Health from the water-works superintendent at Winfield and from various industries located there that almost pure salt is deposited at times in the boilers and on fixtures. It is probable that legislation will be asked for at the coming session of the State Legislature to enforce capping of all abandoned wells to prevent the discharge of salt water and to impound salt water discharged from producing oil and gas wells.

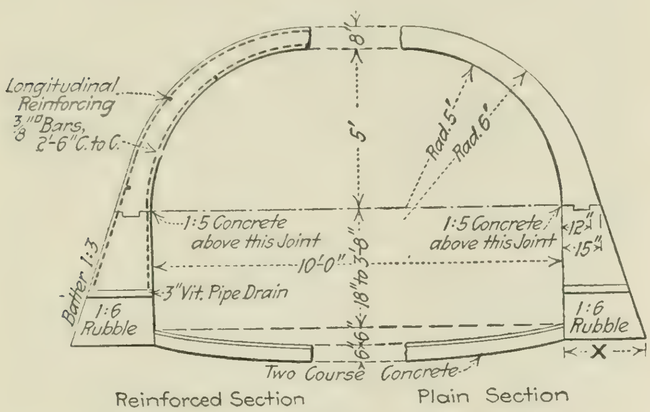
Building a Sewer in Creek Channel at Austin, Tex.

By Julian Montgomery*

In the early part of 1916 the City of Austin, Tex., appropriated $50,000 to build a storm sewer in the channel of Little Shoal Creek, so that it could be filled in and the streets blocked by it be completely opened to traffic. Alternative bids were asked for on (1) plain- and reinforced-concrete and (2) segmental-block construction. All bids on the segmental block were too high to be considered. The portion of the work here described consists of about 3400 ft. of 10-ft. sewer being built by the Dallas Lime and Gravel Co., of Dallas, Tex.

Excavation was begun by the contractor during the latter part of June, 1916. As there is a very small flow ordinarily, little trouble has been experienced from water in the creek. Since construction started, it has been unusually dry.

The method of construction being followed is to pour the bottom first. This bottom (see cross-section) consists of two-course concrete. The lower course is of 1 : 6 mix, 4½ in. thick. The topping is of 1 : 2½ mix, 1½ in. thick. The aggregate for the 1 : 6 concrete is a well-



SEWER CROSS-SECTION, AUSTIN, TEX.

graded unscreened gravel obtained from the Colorado River. That for the topping is specified to be what is locally known as "gutter gravel." It is a coarse sand with the largest particles about ½ in. in diameter. Since it is further specified that the topping shall be laid on the green concrete, the method usually followed is to pour about 30 ft. of the 1 : 6 concrete and then pour the topping directly on this. The lower course is kept the required 1½ in. below the finished grade by a templet that has been cut to the required shape and notched 1½ in. The topping is placed approximately to the required grade by spades. It is then accurately finished by a templet cut to the required section. After the pouring is completed, the bottom is floated and troweled. As it is considered the most important part of the sewer, particular care is being taken to see that it is built to specifications in every detail.

The completed bottom serves as a guide for the side walls. Outside forms are used for these. For the highest walls the outer and inner forms are wired together, and the inside ones are braced against each other. Plums of 10- to 50-lb. stone are allowed in the concrete in any quantity desired, provided there is 2 in. of concrete between them. Horizontal and vertical keyways are left in the tops and ends of the walls as a tie for the arch that comes upon them and to make a better construction joint between the sections of the walls that are poured each time.

The inside forms for the arch are hinged at the center. The outside forms are in two sections. A 2-ft. opening is left between them to receive the concrete and to provide ample space for cutting it.

Bracing the Outer Forms

The contractors have experimented at length on methods of bracing the outer forms. A trigger arrangement composed of a horizontal member, notched at either end and placed across the forms, with inclined struts fitting into these notches and bearing against the forms, was tried first. The main objection to this method was that the play in the joints of the forms was so irregular and of such a nature that the pressure was not distributed equally to each side of the trigger.

The next scheme devised was to brace the outer forms against the banks of the creek. This scheme, though slow, was usually successful. The only trouble encountered at all was due to a slight occasional yielding of the sides of the ditch.

Finally, it was decided to use three rows of bolts, two bolts in each row to the form, in connection with 4x4-in. longitudinal timbers. The timbers run the whole length of the forms, both inside and out; being tied together by the bolts, they constitute an effective bracing. This method permits the forms to be set up in the minimum length of time and is safe. Three-fourths inch bolts are used for the bottom row and ⅝-in. for the other two rows. The bolts are oiled well before being placed. When the concrete has set so that no pressure is exerted on the outer forms, the bolts are drawn. No trouble has been experienced except once or twice, when the workmen inadvertently bent some of the bolts. In such a case a Stillson wrench proved effective in twisting them out. The holes made by the bolts are left open.

Pouring the Plain-Concrete Sections

In the plain-concrete section the plans called for a 12-in. keyway to be left in the crown of the arch for at least 24 hr. after the rest of the arch had been poured. The purpose was to prevent shrinkage cracks. It was decided to pour some of the arch without the keyway and compare the cracks in it with those and in an adjacent section with a keyway. Accordingly the two sections, each 30 ft. long, were poured. Although the weather was very warm, a month of rigid inspection of the section without a keyway revealed no cracks. The section with the keyway, however, did not fare so well. At the construction joints of the keyway, fine cracks were discovered, first on one side and then on the other. Upon examination they were found to extend the thickness of the arch. It is well to mention that the faces of the keyway were sprinkled with water and covered with dry cement before it was poured.

In the light of the knowledge obtained, it was decided to leave the keyway out of all the plain sections, at the same time realizing that probably if the pouring of the keyway had been deferred until the arch had completely set, the cracks at the construction joints of the keyway

*Assistant City Engineer, Austin, Tex.

would have been practically imperceptible at the worst. Since then some 2000 ft. of plain-concrete arch has been run. Subsequent observations have shown a few short longitudinal surface cracks at rare intervals. These cracks do not extend over an inch or so into the concrete.

Where the construction joints are far enough apart, the arch cracks transversely about every 30 or 33 ft., the cracks proceeding in an irregular manner as directed by the line of weakest section.

At places where reinforcement is required, stubs are first placed in the side walls. After the inside form for the arch has been placed, the transverse steel is bent around it and tied to the stubs. Since the splice comes at the springing line, the outside steel is lapped 50 diameters and the inside 25 diameters. The steel is spaced away from the forms by small concrete blocks 1 in. thick made for that purpose. Longitudinal steel serves to keep the proper spacing betwen the transverse bars and is effective as a reinforcement against temperature stresses.

Other Features of the Work

Several interesting features of the work are noteworthy Due to the high cost of reinforcing steel, cement has been used as a reinforcing material as much as possible. All concrete is mixed for at least one minute in a Koehring mixer that turns 20 r.p.m. This is longer than concrete is mixed in the Southwest, as a rule, and probably the first time it has been done so in Austin on any work requiring a large quantity of concrete.

Another interesting feature is that the rock obtained from excavating to subgrade is placed on the intersecting streets for a block or two each way. This rock is a tough limestone and makes an excellent road metal.

It should be mentioned also that all forms are well oiled and that not a single honeycomb has been found next to the inside forms since the work was started. Many competent inspectors have said that the concrete is as good as they have ever seen.

The sewer was designed in the office of M. C. Welborn, City Engineer. The writer is the engineer in charge of the contract work and has immediate charge of the city force-account work. C. A. Newberry has charge of the construction for the Dallas Lime and Gravel Co.

New Standard Hydrant for Cincinnati

The Director of Public Safety of Cincinnati, Ohio, has adopted as standard the hydrant design illustrated in Fig. 1. This design is the work of J. A. Hiller, General Superintendent of the water-works, and its distinguishing feature is the curved standpipe *a* between the hydrant head and the main connection. This is shown in detail in Fig. 2. Another feature designed to prevent freezing of the hydrant is the drip valve *b*, which opens automatically when the gate is closed, thus draining the hydrant head and standpipe into a sump, which has a sewer connection.

The scheme of placing the standpipe, gate valve and connections in an accessible chamber is similar to the practice that has long been followed in Salt Lake City, Utah, described in *Engineering News*, July 13, 1916, p. 66. Exclusive of the chamber, it is stated that estimates of cost of hydrants of the new design are lower than new ones of the present standard type.

The hydrant head and curved standpipe are of cast iron. The 2½-in. and 4½-in. hose nipples are of bronze. The bolts and nuts are of wrought iron. The gate-valve seats and wedge are of bronze (of tensile strength of not

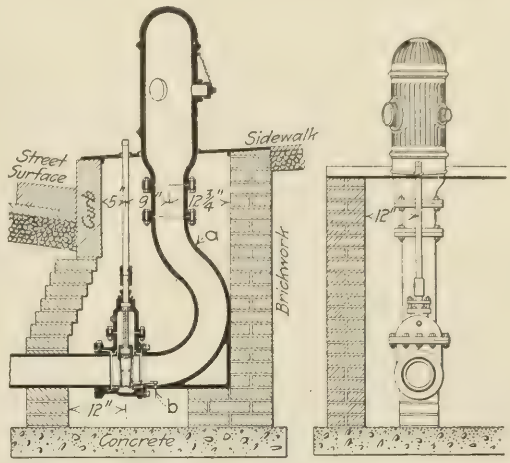


FIG. 1. NEW STANDARD HYDRANT, CINCINNATI, OHIO, WATER-WORKS DEPARTMENT

less than 30,000 lb. per sq.in.), and the stem and stem nut are of manganese bronze (of tensile strength of not less than 50,000 lb. per sq.in.). The stuffing-box is of brass. The drip valve is of bronze, with a ¼ x 1-in. leather-washer cutoff. The leather washer is held in place

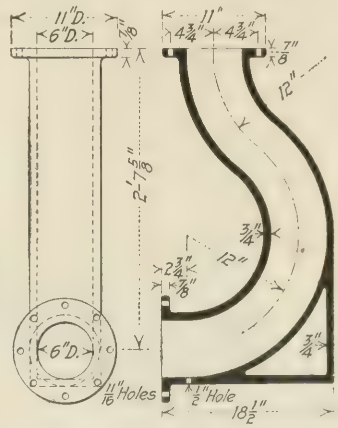


FIG. 2. DETAIL OF CURVED STANDPIPE, CINCINNATI HYDRANT

by a ⅝-in. wrought-iron washer and setscrew. The gate chamber is covered with a ⅝-in. cast-iron plate in two sections, 20½ in. and 44½ in. long respectively. The width of the cover plate is 39½ in.

Coal and Iron Production in the United States in 1916 exceeded all previous records. Approximate figures for the year's production announced by the United States Geological Survey show total shipments of iron ore from United States mines amounting to 75,500,000 gross tons. In 1915 the shipments were 55,493,000 tons. The value of the iron ore produced was $178,935,000, which is an increase of nearly $78,000,000 over the value of the iron ore produced in 1915. Of the total production more than 66,000,000 gross tons were shipped from mines in the Lake Superior district and about 5,300,000 from mines in the Alabama district. The total of pig-iron production will be between 39,000,000 and 39,500,000 gross tons. The year recorded an enormous rise in the market price. Southern foundry No. 2 iron at Birmingham rose from $13.13 to $22. Northern No. 2 foundry at Chicago rose from $18 to $29. Bessemer iron at Pittsburgh rose from $19.85 to $35.95. The bituminous coal production of 1916 is estimated by C. E. Lescher, of the United States Geological Survey, as over 509,000,000 net tons, an increase of more than 66,500,000 over 1915. The production of Pennsylvania anthracite was 88,312,000 net tons, which was about 600,000 tons less than in 1915.

Extending Piers for Double-Tracking B. & L. E. Allegheny River Bridge

The heavy new double-track bridge of the Bessemer & Lake Erie R.R. over the Allegheny river 14 mi. north of Pittsburgh (see *Engineering News* of Feb. 15, 1917) will make use of the five main piers of the existing single-track bridge. As the foundations for these were originally put in with eventual double-track construction in view, the substructure contractor had only to add to them a 32-ft. downstream extension of the shaft proper, except in the case of one pier, where the load is to be so greatly increased that the foundation required reinforcement. Two other piers, Pier A and Pier B, and the abutment at the south end are new.

The north approach viaduct is to be replaced in part by 1200 ft. of high embankment, previously described, and the remainder by two deck truss spans of the new bridge. One of these spans (Pier A to Pier B) will be a simple truss 153 ft. long, and the other (Pier B to Pier 1) will be the end span of a series of three continuous truss spans, 972 ft. long. Another such triple continuous truss, 1142 ft. long, will comprise the rest of the steelwork.

The new Pier A, at the north end (Fig. 1), will be almost buried by the completed fill. It is practically an abutment and is designed to take a considerable thrust from the fill. The foundation is one block of concrete, 78x32 ft. in plan, resting on hard gravel 28 ft. below ground; but to decrease the surface subjected to pressure by the fill, the pier proper is constructed with two shafts, joined at the top by an arch. The shafts are entirely of concrete; the cut-stone masonry facing, of Beaver Valley sandstone uniform with the other piers, has been used only from a point just below the springing line of the arch to the top. The surface of the completed fill will intersect the face of the pier somewhat above this springing line.

FIG. 1. TWO-PART PIER IN APPROACH FILL (PIER A)

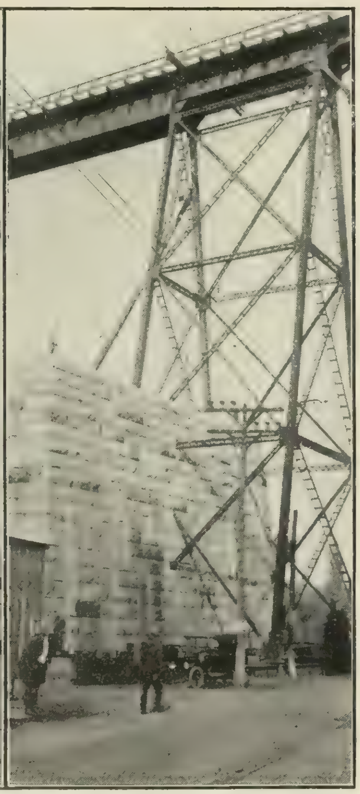


FIG. 2. PIER B BEING BUILT AROUND VIADUCT TOWER

Pier B is the "anchor pier" for the continuous superstructure. Its shaft is 50% thicker than that of any other of the piers, and its spread foundation is 62x89 ft. in plan, with offset steps, each reinforced by horizontal steel rails. It rests on good compact gravel. The construction of Pier B was very much complicated by the fact that one viaduct tower came directly over the site.

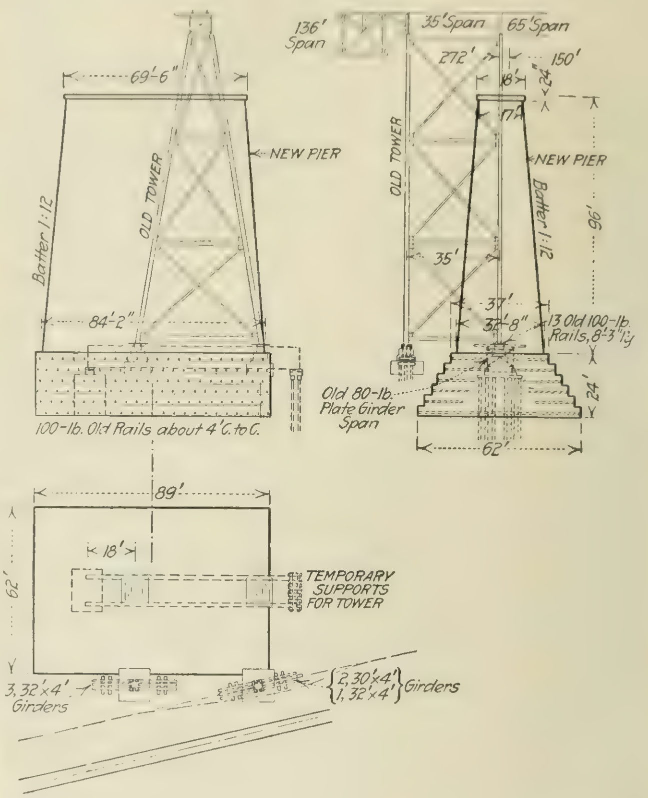


FIG. 3. PIER B AND SUPPORT OF VIADUCT TOWER

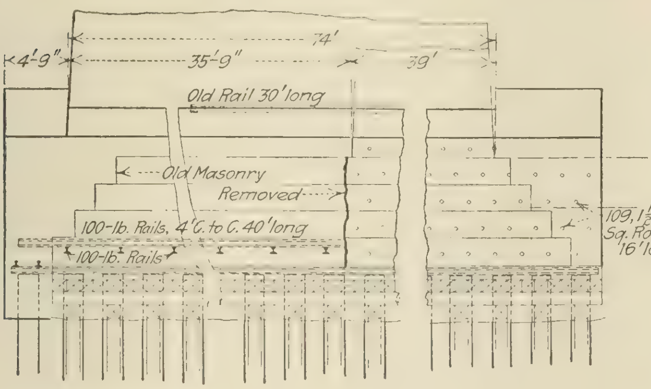
This was particularly troublesome during excavation for the footing, as adequate support for the structure had to be maintained at all times. When it came to building the shaft of the pier, the steelwork was simply concreted into the work (see Fig. 2). When the old bridge is dismantled, the steel will be cut off back of the pier face, and the openings in the facing will be filled with cut stone.

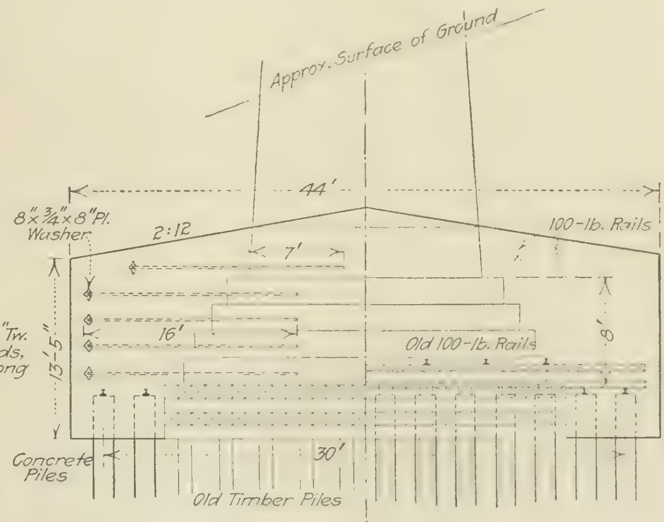
Fig. 3 illustrates how the support of the viaduct tower was handled while the footing was built. A concrete shaft inside the sheeting for the excavation and a pile cluster outside the sheeting were first constructed. Two old 80-ft. girders, reinforced for the column concentrations, were maneuvered into place from each side of the trestle bent and joined by bracing. Cribbing of 20-in. I-beams and 100-lb. steel rails were then placed under the shoes to transfer the pedestal loads to the girder span. The other bent of the tower came just outside the edge of the excavation, but to prevent possible trouble this was also carried on pile clusters, capped by small plate girders.

The long truss spans of the old bridge terminate at Pier 1, which therefore carried the end reaction from only one span, besides the trifling load from the first span of the viaduct. In the new bridge this pier will support

the load from two spans of the heavy continuous structure, and so its foundations, although already of double-track width, required reinforcement.

There were already in place 280 timber piles; it was decided to add to these 126 concrete piles, two rows along each side of the old footing and one row across the downstream end. A cofferdam of United States steel sheetpiling was driven entirely around the pier. Excavation was then carried to the bottom of the capping over the old timber piles, and Cummings precast piles were driven on 3-ft. centers, as close to the old footing as possible. The footing block was enlarged, using 1 : 2½ : 5 concrete, to the dimensions shown. The portion of the footing masonry not under the existing pier shaft





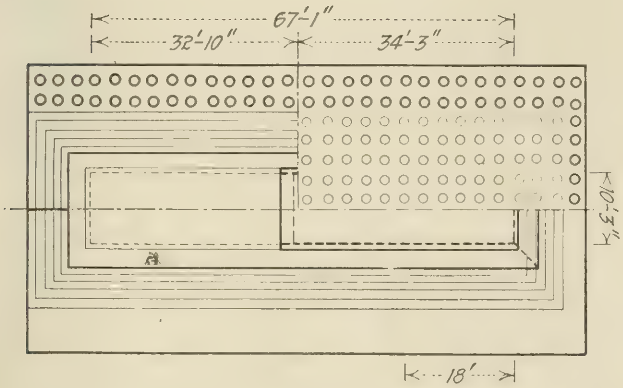


FIG. 4. FOUNDATION REINFORCEMENT, PIER 1

was removed down to the timber grillage, so that a monolithic footing, reinforced with a mat of steel rails, could be constructed over both old and new piles. In the other half of the footing the new work was bonded to the old by 1½ in. square twisted rods, 16 ft. long. These were set in horizontal holes, drilled on about 2-ft. centers into each course of ashlar masonry, and carried heavy plate washers, held in place with double nuts, at the end embedded in the new concrete. The placing of these rods necessitate widening half of the cofferdam.

Cofferdams were required at Piers 2 and 4 to get at the old footing extension, so as to carry up the masonry in the dry. These footings had been carried up to low-water level at the time they were built, but since that day a Government dam in the Allegheny below the bridge site has raised the water about 4 ft. for full pool. It is the intention to surround each of the piers (except No. 5, which is on rock) with 30-ft. steel sheeting driven down to a few feet above the top of the timber grillage. Instead of driving this sheeting entire and using it is a cofferdam for the masonry work, the contractor chose to drive only the half actually required at first, sealing the upstream end against the pier. The reason assigned was that pumpage would be reduced. The steel sheeting for the first half-dam was driven with a steam hammer hung from a stiff-leg derrick. For completing the sheeting a land piledriver was rigged up on cribbing on a barge, with leads overhanging the water.

In building up the pier extensions the corner stones of the old pier were removed in every other course, the headers being taken out and a stretcher of the new course extended into the old work to bond the two halves together. The masonry was backed with 1 : 3 : 5 concrete.

The extension work on Pier 3 did not require a cofferdam, as this pier is located on an island, with the top of the footing course above pool level. Later, however, this pier will be surrounded with sheeting. For Pier 5 a low earth embankment was sufficient in the sluggish waters of the pool, to allow lowering the water level to the top of the old footing courses.

The contractor's plant for the work was quite simple, as the conditions permitted. Each pier was served by

FIG. 5. CONCRETE FILLING IN PIER EXTENSION

one or two stiff-leg wooden derricks, which were used in the successive operations of piledriving, excavating (when necessary) and the handling of concrete, backfilling and cut-stone masonry. The exception to this was in the building of Piers A and B, where concrete was placed in both from a single tower. There was one mixer plant for this tower and another across the highway and West

Penn electric car tracks, near the bank of the river. Running from this shore across to Pier 1 was a service trestle consisting of three pile bents spaced 12 ft. and carrying four 10 x 12-in. stringers. A narrow gage track was laid on this trestle, with a siding between Piers 2 and 3 (on the same three-pile bent construction). Dump buckets loaded at the shore plant were run to the pier sites on flat-cars, where they were handled to the work by the stiff-leg derricks. A separate mixer plant was set up across the river at Pier 5, but it was found more economical to ferry the concrete across the river from the end of the trestle on a barge carrying a couple of bottom-dump buckets. This was due to the fact that but one course of masonry was placed at a time, and was then concreted.

The south abutment is being constructed by railroad-company forces. The reconstruction is under the supervision of H. T. Porter, Chief Engineer of the Bessemer & Lake Erie R.R. W. H. Slifer is Resident Engineer. The substructure contract is held by the Arthur McMullan Contracting Co., of New York City.

Irrigating Seventeen Thousand Acres of Municipal Land

By C. C. Cragin*

Active construction work has been in progress for some time on an irrigation system of 17,000 acres, owned by the City of Las Vegas, N. M., and adjoining its city limits (Fig. 1). This area comprises all that remains unsold of what is known as the Las Vegas land grant, which originally consisted of 475,000 acres, the administration of which is under the control of a Board of Trustees.

Numerous attempts have been made during the past 10 years to finance this irrigation project; but notwithstanding the fact that the irrigable land is contiguous to a community of over 11,000 people, litigation involving the title to the land and water rights has heretofore prevented interesting capital for development of the enterprise. With the uncertainties of title removed and capital provided, the completion of this project, which means much to the City of Las Vegas, is now assured.

The project contemplates the diversion of waters from the Gallinas River and the Sanguijuella and Pecos Creeks, which have a drainage area of 165 sq.mi., extending to an elevation of 12,000 ft. The flow of the Gallinas River is particularly adapted to diversion, being entirely free from the sudden floods common to most New Mexico streams. The snow in the high mountains, lasting each year into August, acts as a regulator, and the flow in the flood seasons rarely exceeds 500 sec.-ft., thus permitting practically 100% diversion. Accurate stream gagings have been conducted by the United States Geological Survey on the Gallinas River for a period of 12 years and show an average annual runoff of 22,000 acre-feet. This represents 90 sq.mi. of the total of 165 mi. of drainage area available. The water is to be diverted through diversion canals to a storage reservoir on a branch of Sanguijuella Creek, for over-year storage.

The diversion dam in the Gallinas River, now completed, has timber flashboards spanning concrete piers with headworks consisting of eight 5 x 5-ft. by $\frac{3}{8}$-in. steel gates. The Gallinas diversion canal is 12,500 ft. long, 30 ft. wide on the bottom and 8 ft. deep, with $1\frac{1}{2}$ to 1 slopes. It has a capacity of 1000 sec.-ft. and required 110,000 cu.yd. of earth and rock excavation. This was completed in time to divert the runoff from the fall rains.

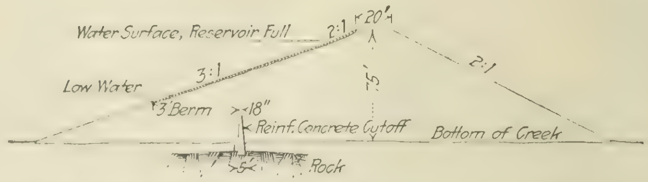


FIG. 2. CROSS-SECTION OF SANGUIJUELLA EARTH-FILL DAM FOR LAS VEGAS IRRIGATION PROJECT

Earth Dam Under Construction

The storage reservoir, known as the Sanguijuella reservoir, will be formed by an earth dam 75 ft. high and 1400 ft. long, with 3 to 1 water slope and 2 to 1 air slope (Fig. 2). The upstream face is to be riprapped 9 in. thick. There will be 450,000 cu.yd. in the 75-ft. dam, when completed, of which about one-third has already been placed. The material is heavy clay, mixed with a good proportion of sand and gravel. It is being excavated by a 40-ton Vulcan shovel, with $1\frac{1}{2}$-yd. dipper. The borrow pit is 5000 ft. from the dam, with a down-grade haul. The material is hauled in $4\frac{1}{2}$-yd. dump-

*Dockweiler & Cragin, Consulting Engineers, San Francisco, Calif.


FIG. 1. LOOKING OVER LAS VEGAS, N. M., TOWARD LAND TO BE IRRIGATED BY NEW PROJECT

cars and side dumped from tracks laid on the two slopes, where it is sluiced by jet into place, toward the center of the dam. The water-supply is obtained by gravity, through the diversion canal, from the Gallinas River. A reinforced-concrete cutoff wall is being constructed to solid rock, between high water on the north end and high water on the south end of the dam. It varies in width from 5 ft. at the bottom and 18 in. at the top to a minimum of 12 in. thick. The maximum height is 31 ft. Concrete is being placed by gravity through 12-in. steel chutes from a 3/4-yd. portable mixer. About 500 ft. from the south end of the dam a low saddle permits the construction of a spillway 100 ft. wide, with a maximum cut of 4 ft. Outcropping rock, below the spillway, forms a natural cascade for overflow water.

There will be a gate tower 10 ft. square and 50 ft. high, founded on solid rock and connected by a bridge to the north haunch of the dam site. The outlet is a concrete arch culvert 212 ft. long, excavated through solid rock in the north haunch of the dam and bonded directly with the cutoff wall. It will be 5 ft. 6 in. wide by 4 ft. 6 in. high in the clear. The excavation is now completed and ready for concrete.

The capacity of the reservoir above the outlet is 23,100 acre-feet, and the area at this capacity is 1100 acres. Provision is made for raising the dam at some future date. The final height will be determined definitely when authentic stream gagings of Sanguijuella and Pecos Creeks are available. These streams can be diverted into the reservoir over a low divide by small diversion dams and canals, 1 mi. and 4 mi. long respectively. When the amount of this additional water is determined, some privately owned land will be brought under the ditch. The main canal will be 18 mi. long and contain about 300,000 cu.yd. of excavated earth and rock.

Other Structural Details

There will be two reinforced-concrete inverted siphons, one under Sanguijuella Creek and one under Pecos Creek. There will be approximately 1200 ft. of steel flumes, with a maximum height of 25 ft. There are approximately 30 mi. of laterals to construct.

An electric generating system for electric lights is now being installed at the dam. When completed, construction work is to be carried on by day and night, insuring completion of the project by the coming spring.

The land to be irrigated starts immediately at the toe of the dam, permitting the gradual decrease in the size of the canal and canal structures after the first headgate, a few hundred feet from the dam. The head of the canal is 5 mi., and the most remote farm on the project 6 mi., from the business district of the city. Fall plowing on a few small tracts, for demonstration purposes, was done, and it is planned to have water available for irrigation by spring.

R. C. Storrie & Co., San Francisco contractors, have undertaken the financing of and construction work on the irrigation system, the Board of Trustees of Las Vegas having shown their faith in the project by taking bonds to the extent of $200,000. Prominent local interests have subscribed for about $25,000 more. The estimated cost of construction, including all necessary laterals, is approximately $500,000. Dockweiler & Cragin, Consulting Engineers, of San Francisco, have been intrusted with the engineering details of the project.

New Jersey Introduces Small Granite Cubes for State Road Paving

The small granite-cube pavement known under the trade name of "Durax" has at last made its entry into this country as a rural-road pavement. It has already been used to a limited extent as a city pavement, but its original purpose, when it was several years ago introduced in Germany and England, was for surfacing rural roads with something more durable than macadam. The following information was furnished by R. A. Meeker, Engineer of the New Jersey Department of Public Roads:

The reason for the adoption of the Durax pavement was that it was not possible to reduce the grade below 7% without considerable injury to adjoining property. It was therefore necessary to adopt some form of block pavement that would not be slippery at this grade. Investigation led to the adoption of the Durax block for this purpose.

The stretch paved is on a part of the Morristown turnpike forming the boundary line between Short Hills

DURAX GRANITE BLOCKS ON MORRIS TURNPIKE AT SUMMIT, N. J.

and Summit. It is 1200 ft. in length and 24 ft. in width. The roadway was prepared by grading the subfoundation to a depth of 10½ in. below the established finished grade and crown. This subgrade was thoroughly consolidated by rolling with a three-wheel roller.

On the prepared foundation there was spread 6 in. of concrete, composed of one part of portland cement, three of clean, sharp sand, free from loam, and five of broken stone. The consistency of the mixture was such that, when rammed, it would not shake like jelly or be displaced laterally with the rammer. It was further required that the rammer must be perfectly flat, so as to secure a smooth surface.

When new concrete had to be laid to connect with sections already set, or partly set, the edge of this latter section was broken off, freed from dust or dirt and properly dampened. Great care was taken to make the surface of the concrete exactly parallel to, and 4½ in. below, the surface of the finished pavement.

Owing to the fact that the concrete was laid late in the fall, it was protected from the effects of the weather, first, by sprinkling in warm weather between the hours

of sunset and sunrise, and second, when the weather became cold, by covering with a thin layer of sand. All carting over the concrete was prevented until it was sufficiently set, and then only when it was covered with planks. Watchmen and barriers against traffic, at all hours of the day, were maintained at the contractor's expense.

The concrete was allowed to set for six days. Upon the concrete foundation a bed of clean, sharp sand, free from loam, gravel or other impurities, was spread to such a depth as to bring the pavement to the proper grade and crown when rammed, and in no case was the depth of sand allowed to be less than 1½ in.

On this layer of sharp sand the granite cubes were laid close to and in contact with each other, so that there was no joint of over ½ in. These cubes were laid so as to break all joints and in concentric arcs. After the cubes were laid as specified, there was spread over the surface ¼-in. screenings, to fill all joints flush to the surface of the cubes. The cubes were then thoroughly rolled with a small tandem roller weighing five tons, until they were brought to the established finished grade and crown at all points.

The Durax blocks are cubes of medium-grained granite. The granite was such as would give at least 20,000 lb. per sq.in. crushing strength combined with a uniform structure and a toughness of 12, as determined by the method of the United States Office of Public Roads and Rural Engineering. The cubes have the following dimensions: All six surfaces approximately square; the edge of the cubes not less than 3 in. or more than 4 in.; the cubes used in any one course not to vary more than ½ in. in size.

After the pavement had been brought to a uniform surface, grout was poured into the joints. Immediately afterward the entire pavement was broomed to a smooth surface, sufficient grout being applied to bring the surface even with the highest part of any of the blocks. The blocks were wet by sprinkling immediately before applying the grout, in order to permit a perfect bond between the blocks and the grout.

The grout was composed of one part of the best quality of standard portland cement and one of clean, sharp sand. The grout was mixed in a box resting on legs of different lengths, so that the mixture readily flowed to one corner of the box, the bottom of which was 6 in. above the pavement.

The mixture was removed from the box to the street surface with scoop shovels, all the while being stirred in the box to prevent segregation. The work of filling the joints was thus carried forward until an advance of 15 or 20 yd. had been made, when the same force and appliances were used to regrout the area in the same manner, excepting that the proportion of the second mixture was two parts of portland cement to one part of sand.

In order to avoid the possibility of causing the grout to become too thick at any point, one workman sprinkled the surface ahead of the sweepers, to insure the penetration of the grout in the joints of the pavement; and to further insure this penetration, squeegee scrapers, 15 to 18 in. in length, were used in addition to the brooms on the last application of the grout.

Within one-half to three-quarters of an hour after the last coat of grout was applied, when the grout between the joints had fully subsided and the initial set had taken place, the whole surface was slightly sprinkled and all surplus grout left on the top was swept into the joints, bringing them up flush and full. After the grouting was done and a sufficient time for hardening had elapsed, so that the coating of sand would not absorb any moisture from the mixture, ½ in. of sand was spread over the whole surface, and the pavement was kept sprinkled until the grout had had an opportunity to set thoroughly.

After the grouting was completed, the road was kept closed and no carting or traffic was allowed over the pavement for 10 days. The contractor was required to erect and maintain strong barricades and furnish watchmen at all times to insure the exclusion of traffic and carting.

One portion of the work was not grouted until freezing weather came on; and in order to complete the work, a bituminous mastic was used in place of the portland-cement grout, with apparently as satisfactory results as in the first method.

The contract price of the pavement was 75c. per sq.yd. for the concrete base and $2.50 per sq.yd. for the Durax block pavement, making the total cost of the work $3.25 per sq.yd., or out of all proportion to the usual cost of country road pavements. The contractor was C. E. McDowell, Newark, N. J.

Experiments with Concrete Ties at Riverside, Calif.

By J. H. G. Wolf*

The following is the record of a test of hollow concrete ties in railway track, which began in October, 1913, and has been continued up to the present time. The design of the tie (which was patented by the writer, Aug. 22, 1916, No. 1,195,634) is shown in the accompanying drawing and photographs, Figs. 1 and 2. The object of the hollow form is to obtain lightness and resilience, and the results have justified that expectation. The outward shape is kept close to that of the wood tie, so that replacements can be made in present track.

The method of rail attachment used is such that the attaching medium is entirely free of the tie structure itself. This has apparently proved practicable and economical. A screw spike passes through an opening in the rail seat into a loosely inserted block of wood some 18 in. long, within the tie. The thrust on curves and from swaying train equipment is thus taken on the upper surface by the cushion block against the raised shoulder, and on the interior by the upward thrust of the block against the concrete surface. This mode of attachment has met the conditions of service and appears to provide a protection against rail spreading which cannot be obtained with a spike or bolt buried solidly in the concrete.

Preceding the main construction, about ten full-sized ties were made for preliminary tests and service trials. The tests in the laboratories of the Department of Civil Engineering, University of California, showed that ties reinforced with four ⅜-in. rods, together with the Clinton wire cloth and the netting, could with center loading be expected to show a breaking strength of 13,000 lb. and an elastic deflection of about ⅜ in. Test ties

*Mills Building, San Francisco, Calif.

placed in a freight yard in Oakland suffered the loss of the outer shoulders almost immediately, which stopped the experiment in the first week. These shoulders were but $\frac{3}{8}$ in. high; those of the ties afterward made are 1 in. high and have not been injured.

The foregoing work was done in 1911, after which a contract was made with a local cement company to take

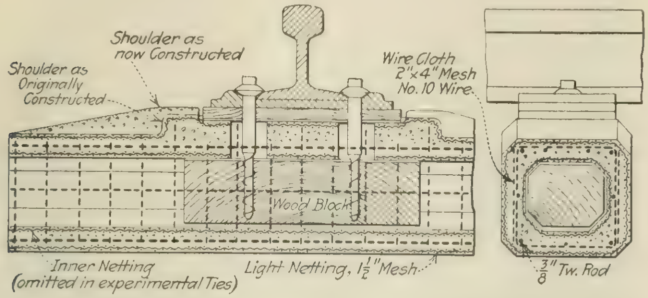


FIG. 1. WOLF HOLLOW REINFORCED-CONCRETE TIE

up the matter. About 120 ties were cast in August and September, 1913, and about 60 of these, seen in Fig. 2, were placed in the track in October 1913. They have been there ever since, except for a few removals for minor failures. The ties are 7x8 in. in cross-section and 8½ ft. long. They have 1½-in. walls, increased to 2 in. under the rail seats, except that a few have straight 2-in. walls throughout. The average concrete is a 1 : 2 : 3 mix.

The stretch of 200 lin.ft. of track comprised in the experiment is on the Riverside, Rialto & Pacific R.R. at Riverside, Calif., which line carries an interurban high-speed electric service in addition to an intermittent but heavy-weight steam railway service. Trains with 87-ton locomotives hauling 20 steel cars loaded to capacity with cement (and weighing up to 70 tons each) pass over this track at high speed to overcome a 2% grade into Riverside. The ties are at the foot of this grade. The embankment is some 10 ft. high, of clay, and in the rainy season is inclined to yield. The ballast is gravel. The rails are light (60 lb. per yd.). Cushion plates of hard oak, 1 x 8 x 12 in., are used instead of unplaned spruce boards, as designed. Plain flat steel plates take the place of regular tie-plates, and common lagscrews are used instead of the more suitable screw spikes.

A few of the ties have split on the ends at the upper surface, owing possibly to expansion stresses. The outer

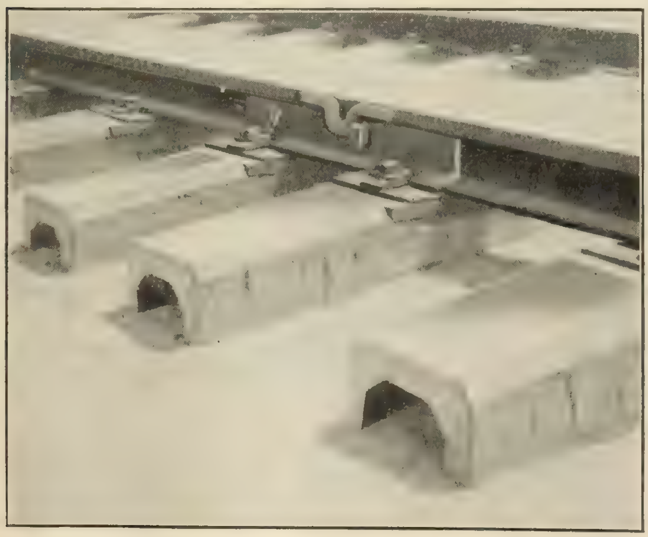


FIG. 2. WOLF REINFORCED-CONCRETE TIES IN PLACE

netting envelope was designed partly to safeguard against this contingency, but was not used in these ties. The concrete under the rail seat of one or two ties is reported to have given way; all other ties are reported to have stood up well during the three years of severe service.

The most noticeable effect of the pounding the ties have received is shown in the tie-plates. The steel plates as well as the hardwood cushions have both cracked and split in numerous instances. This defect has apparently not yet vitiated the experiment. In reviewing results, however, it should be considered, as well as the difficulty of obtaining uniform concrete work at the outset and the difficulties of manipulating properly the metallic reinforcement until the men were familiar with the work.

The riding qualities of the stretch of track on the new ties are pronounced excellent by the trainmen. The swaying of the train, characteristic of the lighter wood-tie track, disappears on the new, and the resilience ob-

FIG. 3. VIEW OF TRACK WITH WOLF TIES

tained makes riding easy. The ties are light enough (320 lb.) to be handled by two men and have less tendency to bury themselves in the ballast than solid concrete ties weighing 500 to 600 lb.

The quantity of materials needed to make up the tie compares favorably with previous designs for a composite tie, being but 0.08 cu.yd. of concrete and 32 lb. of steel reinforcement for the ties with 1½-in. walls. No difficulty was experienced in fabricating collapsible forms. No cost statements are offered, as unit costs vary the country over and with each individual's capital and facilities for doing work economically. The railroad, with its gravel bank and inexpensive common labor and seeking ordinarily to equalize seasonal employment for this labor, is in the best position to profit from an encouraging development of this character.

Acknowledgment is due the Riverside Portland Cement Co. for assistance in the experiments and to the railway officials for the opportunity of making the tests.

Trees Planted by New Machine Replace Railway Snow Fences

By Hugh Smith*

The Minneapolis, St. Paul & Sault Ste. Marie Ry. is making extensive experiments in tree planting, to form windbreaks in place of snow fences. A large nursery has been established by the railroad at Drake, N. D. A planting plan for the right-of-way at the railroad cuts has been evolved.

The planting plan is as follows: On the north side of each cut, eight rows of trees are placed. On the south side of the same cut only four rows of trees are planted, as shown in Fig. 1. The rows are 8 ft. apart, and the trees within the rows are from 3 to 4 ft. apart. The outside row, or the row farthest from the tracks, consists of a planting of carragana; the next row is planted with poplars; the remaining rows are planted in the following order: Green ash, box elder and four rows of willows.

The four-row planting on the south side of the cut is arranged as follows: The outside row is planted to carragana, the next row consists of poplars, and the three remaining rows of willows. The variety of willow best adapted for this planting is the laurel-leaf willow (*Salix pentandra*). This variety seems to be more free from disease and from insect injuries than other varieties.

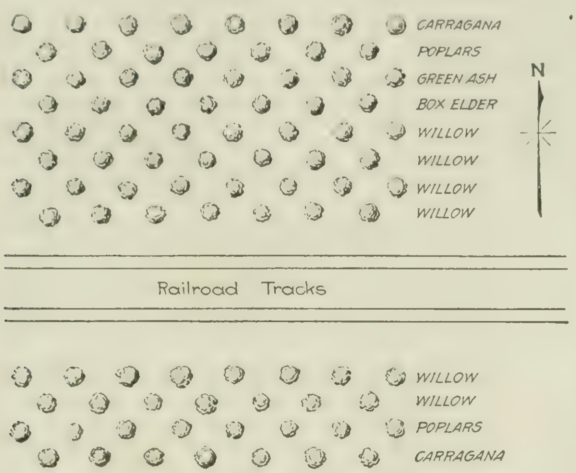


FIG. 1. PLANTING PLAN FOR WIND BREAKS FOR RAILWAY CUTS

This planting plan has not yet been adopted as standard, inasmuch as extensive tests are being made at the Drake nursery with different varieties of trees and shrubs, to determine if possible other species well adapted to the environment.

The tough sod of the virgin prairie is first plowed and then gone over with a disk harrow (see Fig. 2). This is followed by a deeper plowing and by a second disking. The preparation of the land in this manner entails the use of a large amount of labor.

The trees are not planted until one season after the foregoing operations have been completed. The tree planting was at first done by hand. Twelve men in a 10-hr. day working under average conditions planted approximately 2000 trees. The total cost of this planting, taken from accurate cost records, is 1.66c. per tree.

Many disadvantages are inherent in the hand method of planting; labor is a paramount consideration. Men who will give the planting sufficient care are difficult to obtain. The entire method is slow, and only a few miles of track can be planted each year. T. A. Hoverstad, Agricultural Commissioner of the Minneapolis, St. Paul & Sault Ste. Marie Ry., was keenly aware of the defects existing in the old method of planting. He saw the need of a machine of some sort to do the planting, and he has developed one that is a striking success.

This device is shown in Fig. 3. The main part is simply a subsoil plow. Sideboards of steel are attached to the plow and extend to the rear. The space between

FIG. 2. PREPARING PRAIRIES FOR TREE PLANTING

these steel plates is 6 in. Two small plates that act as scrapers are located immediately in back of the large sideboards. Back of the scrapers are two wheels. These are set at an angle, each slanting in. These wheels press the soil about the newly planted trees.

The machine is surmounted by a platform that holds three men. Two men do the planting, and one man drives the team. The machine is made so that the weight of the platform and the men on it is thrown on the two wheels in the rear. Fig. 4 shows the machine in operation. A man walks on each side and hands the trees to the men seated on the platform. The men, working alternately, place the trees in the opening made by the machine. The scrapers throw the dirt back into the opening, and the rear wheels pack the soil.

The machine was given a thorough trial and proved to be satisfactory. During the past season it has given efficient service under constant use. The day's work includes moving from one railway cut to another and does not embrace any long period of steady planting. It is estimated by the men in charge that under good conditions, where steady planting may be pursued, 20,000 trees could easily be placed in a day. The cost of planting under the new method averages 0.2c. per tree.

Two machines have been made since the first model. These will be used next season, so that there will be a total of three in use by the company. These later machines have a few minor changes, but adhere closely to the original model. The inventor is contemplating additional improvements in the land-preparation method, which will further reduce the planting cost.

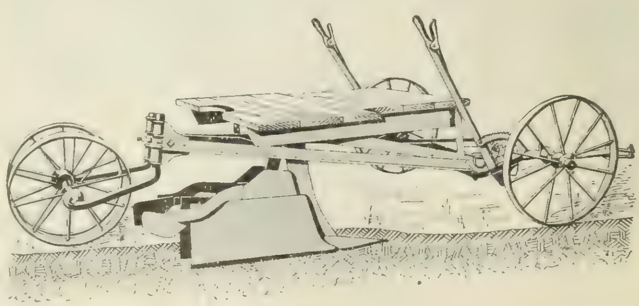


FIG. 3. HOVERSTAD TREE-PLANTING MACHINE

*326 West Minnehaha Boulevard, Minneapolis, Minn.

FIG. 4. TREE-PLANTING MACHINE IN OPERATION

The tree-planting machine is adaptable to many uses. Other railroads, both in the East and the West, have taken an active interest in the work and are planning to adopt similar methods upon their lines. Owners of large estates, orchardists, nurserymen and others having extensive plantings to make will find the machine invaluable. It also offers an opportunity to undertake planting work in townships and also farm plantings under the community plan. The machine promises to be an important factor in the reduction of labor costs in many branches of forestry and nursery work.

Proposed Pacific Coast Highway

By F. W. Harris*

The industrial development on the Pacific Coast has shown the necessity for a highway along the coast, both for military and economic purposes. Unlike the Atlantic Coast the harbors of the Pacific are isolated, as the foothills of the Coast Range extend to tidewater, making very costly the construction of a road adequate for motor-truck service.

Along the Oregon coast the pioneers for many years have been running stage lines on the beaches, according to a schedule based on the nautical almanac. This crude method has given satisfaction, owing to the sparseness of the population.

With the development of such harbors as Gray's and Willapa in Washington, Coos Bay in Oregon and Humboldt Bay in California, the need for a connecting road has long been felt. It is probable that the great stimulus given to the building of wooden ships in these harbors will result in connecting these points with a highway.

Adjacent to these harbors are millions of feet of timber suitable for the manufacture of wood pulp. The question of power for these mills is one of choice between hydro-electric and steam. Coal deposits are very extensive, and with adequate transportation facilities the cost of steam power will compare very favorably with hydro-electric power so far as the average industry is concerned.

The proposed Pacific Coast highway is the first effort made to connect all the harbors on the coast with a modern road; this must be regarded as the first step in industrial development. From a military viewpoint the most important section of this road is between Coos Bay, Oregon, and Eureka, Calif. This section skirts the great barrier of the Siskiyou Mountains, which block the existing Pacific highway on the Oregon-California line.

This coast-line road has one distinction that will make it unique. Along the shores of the Pacific Coast is the only place in the world where a road can be built running in a north and south direction between the thirty-third and the forty-ninth parallels of latitude, which would be free from snow during the entire year. The suggested name for this coast-line road is the Balboa Highway.

*Renton, Wash.

Handling the Cost of Railway Grade Reductions in Accounting

The rules of the Interstate Commerce Commission require railway companies to charge the value of abandoned property to operating expenses. Some of the controversies over this ruling were reviewed in a paper read before the Western Railway Club, on Jan. 17, by Frank Noy, Comptroller of the Chicago, Rock Island & Pacific Ry. A part of his paper follows:

The classification provides that when property is retired and replaced, the original cost thereof, less salvage, shall be charged to operating expenses. This means that if a road makes a cutoff, abandoning part of a curve and shortening the line, the original cost of the old road, less the salvage, shall be charged to operating expenses.

This ruling was contested by the Kansas City Southern Ry., which, in changing its line some years ago, did actually abandon many portions of curves. They left the cost of the old property in the property account, where many railroad accounting officers and executives think it should remain, and the Interstate Commerce Commission brought action against the road to compel it to charge off the original cost of such abandoned roads. The decision was against the railroad, and it has had to make the charges as required by the classification.

Such a rule, however, brings about this situation: If it is decided to reduce the grade of a line by cutting down the humps and filling in the low places in the track, doing the work on the old right-of-way, the entire cost of reducing the grade is chargeable, under this rule, to the capital account. However, if it is decided to reduce the grade by abandoning a certain portion of the line and constructing a new line entirely, the effect of charging the cost of the abandoned line to operating expenses means that a very large portion of the cost of reducing the grade in that way is chargeable to operating expenses. In other words, if the work is done vertically, the charge is to capital account; if it is done laterally, the charge is to operating expenses.

How To Turn Rubbish to Riches is the alluring title of the "Plaindealer's" story (Cleveland, Ohio, Jan. 15, 1917), based on a report on a "survey" of waste collection and disposal in Cleveland. The survey was made by a committee of the City Council and Chamber of Commerce, headed by John P. Becker and David E. Green respectively. The committee submitted the following ten recommendations:

1. That the householder be educated in the proper method of disposing of waste and the forcing of him to comply with the law.
2. That a regular schedule be maintained for the collection of all waste.
3. That a standard type of receptacle be required for rubbish.
4. That the dumps have watchmen stationed on them at all hours and that the owners of private dumps be required to employ watchmen when filling takes any length of time.
5. That the hucksters who dump waste in the streets be prosecuted.
6. That the city pick the dumps.
7. That the city purchase the land to be filled whenever possible and charge for the material furnished to fill private property.
8. That all of the dumps be soaked with oil and burned, and then burned every week thereafter.
9. That a central loading place be established for manure, so that it can be shipped to farmers.
10. That the City Council appropriate $5000 for the purpose of employing some sanitary engineer to work out the most economical and sanitary method of collecting and disposing of the city's waste.

The present system of garbage disposal by reduction is approved, but the report says that the cost of collection in Cleveland is $3.02 a ton, compared with $2 to $2.50 elsewhere.

Engineering Literature

Valuation and Related Problems

Reviewed by Frederic P. Stearns*

VALUATION, DEPRECIATION AND THE RATE-BASE. By Carl Ewald Grunsky, Eng. D., M. Am. Soc. C. E.; assisted by Carl Ewald Grunsky, Jr., E. M., M. Am. Inst. Min. E. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. viii + 387; illustrated. $4

This volume is a notable addition to the small number of books that treat at all fully the subject of valuation and related problems. It contains an introductory discussion; carefully written definitions of many of the terms used; a statement of fundamental principles; a full discussion of the various matters that affect valuation and rate making; chapters relating to the value of real estate, water rights and reservoir and watershed lands; a special chapter by Carl Ewald Grunsky, Jr., on the valuation of mines and oil properties, which includes tables of the production and price of various metals for each year since 1880; tables giving the probable useful life of various articles and expectancy of life and remaining value upon a given theoretical basis; and a series of tables relating to compound interest, present worth, annuities, amortization and depreciation, which cover a wider range of interest rates and length of life than is usual and will therefore be of especial value for practical use.

In many instances the author has recognized that valuation is still in a developmental stage; and after discussing a given subject from one point of view he indicates the other points of view that may be held, without a definite statement of the view that he believes to be correct, thus making his treatment of some subjects suggestive to those who have made a study of valuation problems rather than a guide to the novice.

One chapter sets forth the "Fundamental Principles Which Control When Appraisals of Public-Service Properties Are To Serve as a Basis for Fixing Rates." Some of the principles expressed are those generally accepted, but others relate to matters about which there is still controversy. One of these fundamentals that is eminently sound and yet has often been disregarded is that "a procedure which may be correct if consistently and continuously applied, may be unfair to either the owner or the rate-payer, if introduced at a later period."

Attention is called in the preface to certain features that have been given special consideration or are of a novel type and not to be found elsewhere. One of these is the "non-agreement of the actual life of articles which have a limited period of usefulness with their probable or normal life." The discussion of this subject is said to show the "great advantage in adopting, instead of 'present value,' a rate-base without deduction of depreciation," and this in turn leads to the recommendation of "the method of procedure which he (the author) has named the Unlimited Life Method."

In regard to the non-agreement of the actual with the normal life of articles of property, it may be questioned whether it has more than academic value "as a factor affecting the required earnings." To take account of this non-agreement introduces complications in a matter that is necessarily an approximation on account of the uncertainty of the length of life of the articles that make up a public utility, especially when such length of life is largely dependent upon inadequacy and obsolescence. It also is a feature of limited importance at the present time, in view of the lack of agreement on the broader question as to how the annual sum to be earned for depreciation should be computed, even if the life of the various articles were accurately known.

The author suggests that when a variation of actual from normal life of articles is disregarded "the anomaly results of having to carry in the accounts a part of the cost of articles no longer in use but still in the process of amortization and also of having wiped out the entire cost of others still in service."

The more important of these anomalies is avoided under systems of accounts prescribed by the Interstate Commerce Commission and by other public-service bodies, which provide that depreciation charges with respect to any article shall cease when its cost has been equaled, and that if an article is retired before the depreciation charges equal its cost the balance shall be charged at the time of retirement.

In regard to the "great advantage in adopting, instead of 'present value,' a rate-base without deduction of depreciation," the author recognizes that, under certain methods of depreciation accounting which return annually to the owner of property a part of the money invested in individualized articles, there should be a deduction for the depreciation of such articles when determining a rate-base. He therefore recommends what he has termed the Unlimited Life Method, which will not require the deduction of depreciation. This method is not referred to in the chapter of definitions, but it is variously defined in different parts of the book. The author says (page 184): "The Unlimited Life Method is the most flexible. It may be so applied as to give identical results with the Equal Annual Payment and Sinking Fund Method, or it may be applied to vary somewhat therefrom so as to make the earnings requirements least in the early years."

The principal definition of the method (page 166) is substantially as follows: A method in which no part of the investment need be returned to the owner, except as he is allowed to recover in the earnings the cost of each article as replaced. Under this definition the Unlimited Life Method is what is more generally known as the Replacement Method.

The trend of the times is not toward a method which excludes from the earnings sums sufficient to cover the depreciation of the various plant units as it accrues, but rather toward the inclusion of such sums, thus according with the view laid down by the United States Supreme Court in the Knoxville decision, that the owner of a public utility is entitled to sufficient earnings to keep the investment intact. This view accords also with the sys-

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tem of accounts prescribed by the Interstate Commerce Commission for large telephone companies, and is in increasing accordance with the rules prescribed from time to time by the same commission for the accounting systems for steam roads. Many would think it a step backward to adopt a method that did not conform to these sound financial ideas.

Cash earnings to cover accrued depreciation, even though the amount be somewhat approximate, furnish a better asset for the owner of a public utility than an implied obligation of the public to pay at some future period, which may be repudiated by the public of that period or may become illegal.

The amortization and depreciation tables at the end of the volume are extended and valuable.

While, as indicated above, the book in some of its main features seems not to make recommendations along practical and progressive lines, it is the result of personal contact, long experience and much study of the valuation problem, has been written with much care and contains many valuable ideas, so that it should have a place in the library of all those interested in valuation.

The Revival of Natural Philosophy

GENERAL PHYSICS: An Elementary Treatise on Natural Philosophy—By William S. Franklin and Barry MacNutt. New York: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. viii + 604; 479 illustrations. $2.75 net.

The subtitle of this book is the key to the contents. It is intentionally a somewhat dilute philosophical discussion of those natural phenomena whose study we commonly include under "physics." In recent years it has come to be realized that students of the "natural philosophy" of 70 years ago had proportionately a better grasp of physics, so far as the science had then been developed, than have the students of today in their understanding of modern physics. This realization has brought an insistent demand to return to the methods of Comstock and the other old teachers of natural philosophy—methods which involved only the explanation of laws by every use of homely, practical, everyday, close-to-life occurrences, but methods which had been forced into the discard by the school of pedants who secured almost nation-wide control of physics teaching. The authors of this text have long been known among the leaders in the reform, and the present book is a continuation of their efforts.

The book runs the whole gamut of classical physics, covering mechanics, dynamics, hydraulics, heat, electricity, magnetism, light and sound. There is nothing particularly strange encountered, except in the discussions on thermodynamics, where great attention is paid to entropy. The authors lead up to these topics by a discussion of degenerative processes in general and finally narrow down to thermodynamic degeneration. They endeavor to show that entropy is a measurable property of a substance and that the different values of such measured property, before and after a thermodynamic degeneration, measure the sweeping process. The authors' approach is very acceptable indeed to people who have a considerable knowledge of physics and an inherent and sustained interest in the science, but it will be an extremely difficult, if not an impossible, task to try to make young students absorb this line of reasoning. It would seem that the first approach of students to these very abstract concepts might better be made by going through some of those channels that allow a distinct mental picture to be drawn of what this peculiar thing, entropy, is. All these pictures are known to be faulty; but so far as they go, they furnish an easier approach. The inadequacies and inconsistencies of them can be later eliminated, as the student is more capable of approaching such a presentation as here given.

City Government and Activities

THE AMERICAN CITY: An Outline of Its Development and Functions—By Henry C. Wright, First Deputy Commissioner, Department of Public Charities, New York City. [The National Social Science Series.] New York: A. C. McClurg & Co. Cloth; 4x7 in.; pp. 178. 50c. net.

A birdseye view of the modern city—its government, finances, various activities and its reaction for good or ill on its inhabitants—is presented for the information and stimulus of the general reader. The spirit of the book is admirable, and on the whole the information seems to be reliable; but at some points the author has relied on old data, drawn wrong conclusions or expressed himself obscurely. Probably these slips will do but little harm among the class of readers for whom the book is intended.

New Edition of Slocum's Hydraulics

ELEMENTS OF HYDRAULICS—By S. E. Slocum, B. E., Ph.D., Professor of Applied Mathematics in the University of Cincinnati. New York: McGraw-Hill Book Co., Inc. Second edition, revised and enlarged. Cloth; 6 x 9 in.; pp. xvi + 329; 221 illustrations. $2.50 net.

The appearance of Professor Slocum's second edition in a few months after the appearance of the first edition seems to indicate the success of his idea, which, as pointed out in the review in *Engineering News*, Sept. 16, 1915, was to break away from academic presentations of pure theory in order to secure the interest of the student and to visualize the abstractions that once were too exclusively dealt with.

In its general structure and main details the book remains much as it was before. The effect of practicality has been heightened by dropping the academic terms "hydrostatics," "hydrokinetics" and "hydrodynamics." In place of these are the eminently sensible designations "pressure of water," "flow of water" and "energy of flow." The text is greatly improved and strengthened by inserting a discussion on the use of exponential formulas for flow of water. There are additions on strength of pipe, flow over weirs, siphons, water hammer, and surge-tank problems.

Symposium on Industrial Unrest

LABOR DISPUTES AND PUBLIC SERVICE CORPORATIONS: Proceedings of Academy of Political Science in the City of New York—New York: Columbia University. Vol. VII, No. 1 (January, 1917). Paper; 6x10 in.; pp. iv + 189. $1.50, paper; $2, cloth.

A collection of 15 articles by 20 men, bearing upon the increasing industrial unrest and upon mediation and compulsory arbitration, is included in this volume. The book is divided into four sections: (1) "Government Mediation and Arbitration," (2) "Trade Unions and Compulsory Arbitration," (3) "Trade Unions and Mediation and Conciliation," (4) "Recent Aspects of Labor Disputes." The fourth section discusses arbitration of recent labor disputes and also the Adamson Act, from the employees', employers' and public viewpoints. Touching upon the Adamson eight-hour railway law, Oscar S. Straus states that a representative government is weakest on the eve of an election.

Simple Advanced Electrotechnics

ELECTRICAL ENGINEERING, ADVANCED COURSE—By Ernst Julius Berg, Sc. D., Professor of Electrical Engineering, Union College, author of "Electrical Engineering, First Course." New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 332; 163 illustrations. $3.50 net.

Professor Berg has here prepared a book on the more advanced phases of electrical engineering in a way that a student with only the usual mathematical training can grasp. It is really the written basis of Professor Berg's lectures at Union College, covering transient phenomena, electrostatics, radiation, etc. These are fields which have been adequately presented now for several years by such authors as Steinmetz, Heaviside, Maxwell, Hertz, Fleming, Kelvin, Gray, Bedell and a host of others, but the earlier books have been available only to those of considerable mathematical knowledge.

Naval Architect's Handbook

NAVAL ARCHITECT'S AND SHIPBUILDER'S POCKET-BOOK of Formulas, Rules and Tables and Marine Engineer's and Surveyor's Handy Book of Reference—By Clement Mackrow, late Member of the Institution of Naval Architects, late Lecturer on Naval Architecture at the Bow and Bromley Institute, and Lloyd Woollard, Royal Corps of Naval Constructors, Member of the Institution of Naval Architects, Instructor in Naval Architecture at the R. N. College, Greenwich. New York: Norman W. Henley Publishing Co. Eleventh edition, thoroughly revised, with a section on aëronautics. Leather; 4x7 in.; pp. xii + 742; 264 illustrations. $5.

This is the eleventh edition of a British book containing sections on tabloid mathematics, weights and measures, moments of figures, mechanics, hull design, propellers, powering, properties of shipbuilding materials, admiralty tests, projectiles and armor, ship-service equipment, Lloyd's requirements and Board of Trade requirements. A feature of this edition is a new section on aëronautics.

Field Astronomy for Surveyors

A MANUAL OF FIELD ASTRONOMY—By Andrew H. Holt, Instructor in Civil Engineering in the College of Applied Science of the State University of Iowa. New York: John Wiley & Sons, Inc. Leather; 4 x 7 in.; pp. x + 128; illustrated. $1.25 net.

The purpose of this new work on field astronomy is to furnish a text sufficiently concise to fit into a college course in surveying and yet give enough of the fundamentals to enable its use in general practice—a combination which the author thinks has not been accomplished hitherto.

Without attempting to pass on the correctness of the author's contention, there is every evidence that his little book does fill the bill. It is clearly and concisely written and much more complete than the usual college-student manual.

The Electric Telephone

PRINCIPLES OF THE TELEPHONE: Part I, Subscriber's Apparatus—Prepared in the Extension Division of the University of Wisconsin by Cyril M. Jansky, B.S., B.A., Associate Professor of Electrical Engineering, and Daniel C. Faber, E. E., Assistant Professor of Electrical Engineering, University of Wisconsin. New York: McGraw-Hill Book Co. [Industrial Education Series.] Cloth; 6x9 in.; pp. xiii × 160; 125 illustrations. $1.50 net.

This book forms another addition to the industrial-instruction texts issued for the University of Wisconsin's extension work, and it conforms both in readableness and technical content to the high standards set by previous volumes. The parts relating strictly and only to telephone work would make a much smaller book, but to secure the completeness needed in the use intended there are scattered through the pages elementary theoretical explanations of electrical circuits in general.

Only the subscribers' end of the line is described—receivers, transmitters, arresters, switches, bells, condensers, assembed sets, instrument wiring, house wiring, etc. The book covers local battery, common-battery and intercommunicating systems, and both Bell (Western Electric Co.) and independent equipment.

Practical Arithmetic for Engineers

ARITHMETIC FOR ENGINEERS: Including Simple Algebra, Mensuration, Logarithms, Graphs and the Slide-Rule—By Charles B. Clapham, Lecturer in Engineering and Elementary Mathematics at the University of London, Goldsmiths' College. New York: E. P. Dutton & Co. Cloth; 6 x 9 in.; pp. xi + 436; 149 illustrations. $3 net.

The many works appearing on practical mathematics for engineering students would seem to indicate that this is not a subject easily covered. The present book, in common with the others referred to, is intended to be directly useful, all purely academic operations, such as highest common factor and recurring decimals, being omitted. Numerous examples (with answers) are presented that should interest men in the drafting room, machine shop and laboratory as well as those studying for engineering pursuits. A chapter on the slide-rule promises to be helpful to the novice. Other chapters deal with logarithms and graphs.

Elements of British Leveling

LECTURES ON LEVELING: A Practical Course of Instruction Adapted for the Use of Engineering and Survey Students, Planters, Miners and Others in the East—By V. J. Martin, Assoc. M. Inst. C. E., of the Public Works Department, Federated Malay States. Singapore, Straits Settlements: Kelly & Walsh, Ltd. Cloth; 6 x 9 in.; pp. iv + 131; illustrated.

Most of the interest in this book to American readers lies in its curiosities. It is a very elementary and particular account of English practice and instruments of leveling. The chapter on "Some Simple Leveling Instruments and Appliances" contains descriptions of instruments as simple as "boning rods" and is of interest in showing how rough-and-ready results may be accomplished with a little ingenuity and no other appliances than can be made on the job.

The work is worth a place in a collector's library, but would hardly be used as a textbook where American practice prevails.

What Are Mining Stocks Worth?

ENGINEERING ANALYSIS OF A MINING SHARE—By J. C. Pickering. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. viii + 95. $1.50 net.

The considerations entering into the analysis of a mining venture have been instructively set forth by Mr. Pickering. There is little doubt that the great mass of "investors" in mining stocks do not analyze their purchases very sharply. Mr. Pickering, for the sake of simplicity, applies his analysis to a single share, stating that obviously the analysis by shares is equivalent to the analysis of the whole property. He endeavors to follow a line of investigation based on data available to the average shareholder. The discussion is confined to gold, copper, silver, lead and zinc. Of special worth is the chapter that deals with the determination of the value of a mine or mining share. Following this is a chapter on mining versus industrial and other investments, which should be of very general interest.

Sabin on Paints and Varnishes

THE INDUSTRIAL AND ARTISTIC TECHNOLOGY OF PAINT AND VARNISH—By Alvah Horton Sabin, M.S., M. Am. Soc. M. E. New York: John Wiley & Sons, Inc. Second edition, thoroughly revised. Cloth; 6 x 9 in.; pp. x + 473; illustrated. $3.50.

The man who reads for entertainment as well as instruction will appreciate this book. It is a technical work in the true sense of the word; but it is written with the rare style of a classical scholar, and humor is not lacking. It is labeled a second edition, but it is virtually a new book—due to the development of the art and the changed affiliations of the author—he is now a paint and not a varnish man. This second edition is a great deal better than the first one for the peculiar reason that, not being any longer a varnish man, the author feels free to speak more openly of the varnish business and, now being a paint man, he knows more about the paint business than before.

The book opens with a section of definitions and brief fundamental descriptions, such as how varnish is made; what linoxyn is; what pigments and paints are. This is followed by a discussion of the history of paints and varnishes, introducing the original quotations, Greek and Latin, about the earliest processes.

The author leads up to the technology of varnish by a discussion of linseed oil; after finishing with varnish, he runs off into japans, driers, rosin, shellac and the other spirit varnishes, cellulose and celluloid coatings, etc. There is after this a most informing section on paint. It discusses and describes mechanical and chemical properties of the better-known pigments. It outlines the distinguishing features of their employment in oils, varnishes and japans. What may be termed the manufacturing, the paint man's side of the book ends with some notes on Chinese and Japanese lacquers, discussing both manufacture and application.

The rest of the book is devoted essentially to the engineering application of paints and varnishes and materials intended to serve the same purpose of protection or ornamentation. This engineering section is arranged under two heads—(1) protection of metals against corrosion, and (2) house and carriage painting and furniture varnishing.

The notes on protection of metals open with a discussion of the performance of concrete coatings and of concrete over paint, and go into the cleaning of steels and the actions of the various coatings. The technique of application is discussed from the paint makers' viewpoint. There are text and tabulated results of innumerable tests. Special chapters on pipe coatings and ship-bottom paints are built up in much the same general way.

Forestry for Young America

THE BOOK OF FORESTRY—By Frederick Franklin Moon, M.F., Professor of Forest Engineering, New York State College of Forestry at Syracuse. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. xvii + 315; 64 illustrations. $2.

The principles and practices of forestry with attention to the conservation and use of natural resources are simply and entertainingly outlined in this volume. Although designed more particularly for youthful readers the book is suitable for persons of any age who wish to get a general view of forestry. Part I deals with forest growth, management and utilization and Part II contains text and cuts designed to aid in the identification of growing trees and of wood that has been cut.

The Railroads' Plan for Improving the Railroad Situation

GOVERNMENT PARTNERSHIP IN RAILROADS—By Mark Wymond. Chicago: Wymond & Clark. Cloth; 6 x 9 in.; pp. 178. $1.50.

Mr. Wymond is a good spokesman for the railroads, assuming, what seems to be true, that he represents them with his solution of the troublesome plan of railway regulation—much in the same unofficial way that he represented them with his earlier book, "Railroad Valuation and Rates" (reviewed in *Engineering News,* July 20, 1916). Mr. Wymond's candid and quiet statements will gain a wider hearing, in spite of his obvious leanings, than the once familiar broadside loaded with bombast and exaggeration.

His argument is that regulation of extensive systems by state commissions is patchwork, while good results dictate a single Federal commission. On account of the great burdens of the existing Interstate Commerce Commission, he would reorganize it into a directing body placed over eight district commissions on which there would be specific representation of agricultural and industrial shippers, railway labor and railway administration. He would have the Government guarantee the interest on railroad investment and have the surplus above a fair return divided some way between the roads and the public. He would permit pooling traffic to reduce the cost of service and the need of extensions.

Mr. Wymond finally turns his attention to Government ownership, intimating that it is the alternative of complete Federal control. He cites experience elsewhere and advances the opinions that the motives causing it in other countries are lacking here, that it will increase rates, that it will introduce politics into industry, that it will introduce a fatal experimental period, that states will lose millions in tax revenue, that it will allow shippers no redress for losses and that various other dire results will be seen.

American Biography Continued

THE NATIONAL CYCLOPÆDIA OF AMERICAN BIOGRAPHY. Edited by Distinguished Biographers. New York: James T. White & Co. Vol. XV. Cloth; 8 x 11 in.; pp. 416; 700 illustrations. $10.

Biographical sketches of engineers to the number of forty odd are included in this fifteenth volume of American biography. The subjects of these sketches include such men as Spencer Miller, Ralph Modjeski, George W. Kittredge, Onward Bates and some others of national reputation, and some of much less renown.

In general, the sketches are interesting and give the essential facts in the engineering careers of these men. Unfortunately some of the sketches of living men are written with such an overload of fulsome praise as to be in rather bad taste in a volume designed for the use of future generations as well as for contemporaries.

The fifteen volumes of the National Cyclopædia of American Biography now contain biographical sketches of several hundred engineers and inventors and are so thoroughly indexed as to furnish an important work on engineering and industrial history. It is increasingly evident that engineers are playing and will continue to play one of the most important rôles in current history, and any conscientious effort to compile and publish data of historical value in regard to their lives and works is surely to be commended.

Guide to Export Trade

EXPORT TRADE DIRECTORY, 1917-18: Export Merchants, Manufacturers' Export Agents, Foreign-Exchange Bankers, Foreign Freight Forwarders, Steamship Lines, Foreign Consuls, etc., in Principal Ports of the United States—Compiled under the supervision of B. Olney Hough, Editor, "American Exporter." New York: Johnston Export Publishing Co. Fifth edition. Cloth, 6x9 in.; pp. 536. $5.

The new edition of the "Export Trade Directory" lists 1562 American export houses, of which 1295 are in New York City. The term "export merchant" in this book refers both to merchants who buy on their own initiative and risk and export commission houses which buy only those specific goods and quantities that foreign importers instruct them to buy. Also under this heading are included the buying offices in the United States of foreign merchants, mining and railway companies and industrial establishments of all sorts whose headquarters or business interests are in other countries. The book is divided into 12 parts and a general index of names. Part 3 is a list of leading bankers engaged in foreign-exchange business. Then there are lists of marine-insurance companies in New York City, of foreign-freight forwarders, and of steamship services to foreign ports.

With the new year the New Jersey State League of Municipalities began the publication of a bulletin entitled "New Jersey Municipalities" (address Claude H. Anderson, director of Bureau of Municipal Information, Princeton University Library, Princeton, N. J.).

Under the chairmanship of Arthur N. Pierson, a member of the assembly, or lower branch, of the New Jersey Legislature (address State House, Trenton, N. J.), a Commission for the Survey of Municipal Financing submitted a half-dozen bills to the New Jersey Legislature of 1916, providing for some thorough-going reforms in the control of municipal bonds and municipal financing generally. One of these bills, limiting the life of municipal bonds to that of the improvement they are to pay for and containing other admirable regulative features, became a law in 1916; but the other bills were vetoed by the governor, although passed by the legislature. The commission was continued. The report before us gives the further ideas of the commission regarding a thorough-going system of budget control or a definite yearly program of municipal expenditures correlated with receipts; and also regarding the administration, regulation and supervision of sinking funds.

A new topographic map of Washington, D. C., and vicinity has just been issued by the United States Geological Survey. It is the result of recently completed fieldwork and represents as high accuracy and refinement as can be attained in a map printed on the scale used. It shows an area of 465 sq.mi., which includes almost every form of topography, from the lowlands along the Potomac Drive to the broken country in Rock Creek Park and the picturesque gorge of the Potomac above the city. Black is used for artificial features, such as railroads, roads and houses; blue for streams and water surfaces; and brown is used for the 10-ft. contours. An automobile edition shows routes of all-the-year-round good roads in bright red and connecting links in dotted red lines. The scale used is 2 in. to the mile, or 1 to 31,680. The map measures 44x53 in. Its price is 25c. retail, or 15c. each in lots of 50 or more. (Washington, D. C., Director, United States Geological Survey.)

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ADMINISTRATIVE REPORT AND ECONOMIC AND GEOLOGICAL PAPERS: Year Book for 1915—Work in coöperation with United States Geological Survey, State Geological Survey, and University of Illinois. Urbana, Ill.: State Geological Survey. Bulletin No. 33. Cloth; 7 x 10 in.; pp. 180; illustrated.

BETTER CITY PLANNING FOR BRIDGEPORT: Some Fundamental Proposals to the City Plan Commission—By John Nolen, Consultant on City Planning, with a Report on Legal Methods of Carrying out the Changes Proposed in the City Plan by Frank Backus Williams, of the New York Bar. Bridgeport, Conn.: The Commission. Paper; 9 x 12 in.; pp. xx + 159; illustrated.

Mr. Nolen here makes a final report, following his preliminary report of 1915. Main lines of communication, centers and proposed street changes in the downtown district, block and lot subdivisions, districting, parks and playgrounds are the chief subjects considered.

BLAST-FURNACE CONSTRUCTION IN AMERICA—By J. E. Johnson, Jr. New York: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. xi + 415; 247 illustrations. $4.

THE BULLETIN OF THE AFFILIATED ENGINEERING SOCIETIES OF MINNESOTA—Annual Edition, Vol. I, 1916. St. Paul, Minn.: Civil Engineers' Society of St. Paul, Minnesota Surveyors' and Engineers' Society. Paper; 6 x 9 in.; pp. 217; illustrated. 50c.

CALIFORNIA WATER PROBLEMS—Report of conference held Nov. 25, 1916, under instructions of the California Legislature to recommend "a unified state policy with reference to irrigation, reclamation, water storage, flood control, municipalities and drainage, with due regard to the needs of water power, mining and navigation." Sacramento, Calif.: [State Water Commission.] Paper; 6 x 9 in.; pp. 125.

CARPENTRY—By Ira Samuel Griffith, Chairman of the Manual Arts Department, University of Missouri. Peoria, Ill.: The Manual Arts Press. Cloth; 5 x 8 in.; pp. 188; 152 illustrations. $1.

THE CITY MANAGER AND CITY ENGINEER-MANAGER Plans of Municipal Government—By Kenyon Riddle, Municipal Engineer. Abilene, Kan. Paper; 6 x 9 in.; pp. 31.

CITY MILK SUPPLY—By Horatio Newton Parker, Member, International Association of Dairy and Milk Inspectors. New York: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. xi + 493; 63 illustrations. $5.

CITY PLANNING—By Frank G. Bates, Associate Professor of Political Science, Indiana University. Indianapolis, Ind.: Indiana Bureau of Legislative Information. Bulletin No. 8, December, 1916. Paper; 5 x 7 in.; pp. 31.

COBALT ALLOYS WITH NON-CORROSIVE PROPERTIES—By Herbert T. Kalmus, B. Sc., Ph. D., and K. B. Blake, B. Sc. Ottawa, Ont.: Department of Mines. Paper; 6 x 9 in.; pp. 51; illustrated.

A COMPARATIVE BACTERIOLOGICAL STUDY OF THE WATER-SUPPLY OF THE CITY AND COUNTY OF DENVER, COLORADO, February, 1917—By Walter G. Sackett. Fort Collins, Colo.: Experiment Station, Colorado Agricultural College. Bulletin 225. Paper; 6 x 9 in.; pp. 14; illustrated.

COST KEEPING AND CONSTRUCTION ACCOUNTING: Adapted to Any Work Consisting of Numerous Items, Departments or Divisions on Which Detailed Unit Costs Are Desired—By G. Ed Ross, Auditor, State Highway Department. Salem, Ore.: The Author. Cloth; 5 x 8 in.; pp. xiv + 59; illustrated.

THE DESIGN OF RAILWAY LOCATION: A Study of the Physical and Economic Conditions That Control the Location of Railways in Order That Their Operation May Be at Maximum Safety and Efficiency—By Clement C. Williams, Assoc. M. Am. Soc. C. E. New York: John Wiley & Sons, Inc. Cloth; 6 x 9 in.; pp. vii + 517; 106 illustrations. $3.50 net.

ELECTRICAL EQUIPMENT, ITS SELECTION AND ARRANGEMENT, with Reference to Factories, Shops and Industrial Plants—By Harold W. Brown, B. S., M. M. E., Department of Electrical Engineering, Cornell University. New York: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. xiii + 229; 109 illustrations. $2 net.

ENGINEERING OFFICE SYSTEMS AND METHODS, Together with Schedules and Instructions for the Collection of Preliminary Data for Engineering Projects; Sampling, Inspecting and Testing Engineering Materials; Conducting Domestic and Export Shipping Operations, etc.—By John P. Davies, Assoc. M. Am. Soc. C. E. New York: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. xvi + 544; 244 illustrations. $5 net.

This volume, which has gone to second printing with corrections, was reviewed in our issue of May 20, 1915.

FAILURE OF BRASS: 1. Microstructure and Initial Stresses in Wrought Brasses of the Type 60% Copper and 40% Zinc—By Paul D. Merica, Associate Physicist, and R. W.

Woodward, Laboratory Assistant, Bureau of Standards. Washington, D. C.: Bureau of Standards. [Technologic Paper No. 82.] Paper; 7 x 10 in.; pp. 72; 120 illustrations. 20c. a copy from Superintendent of Documents.

FLUSHING: Its Place in the Street-Cleaning Field—By Raymond W. Parlin, Engineer with the New York Bureau of Municipal Research. Newark, N. J.: American Society of Municipal Improvements. Paper; 6 x 9 in.; pp. 29; 22 illustrations.

Probably this is the most complete collection of cost data on street flushing available. It includes an investigation of this method of street cleaning in several cities, and the analyses of cost are carried out in great detail.

GAS CHEMISTS' HANDBOOK—Compiled by Technical Committee Subcommittee on Chemical Tests, 1916, A. F. Kunberger, Editor. New York: The American Gas Institute. Cloth; 6 x 9 in.; pp. 354; 73 illustrations. $3.50 postpaid in the United States and Canada.

HIGH FREQUENCY APPARATUS: Its Construction and Practical Application—Thomas Stanley Curtis, Editor. New York: Everyday Mechanics Co., Inc. Cloth; 5 x 7 in.; pp. xvi + 243; illustrated. $2.

HIGHWAYS AND WATER RESOURCES OF OREGON: Report for Two Years Ended Nov. 30, 1916, of John H. Lewis, State Engineer, Salem, Ore.—Paper; 6 x 9 in.; pp. 165; illustrated.

THE HOMESTEAD COMMISSION: Annual Report, 1916—Boston: The Commission. [No. 103.] Paper; 6 x 9 in.; pp. 79; illustrated.

HOW TEXAS MUNICIPALITIES CAN SOLVE THEIR SEWAGE DISPOSAL PROBLEMS—By Charles Saville, Director of Public Health, Dallas, Tex. Reprint of an address before the League of Texas Municipalities. Paper; 6 x 9 in.; pp. 13.

HYDROMETRIC SURVEYS: Report of Stream Measurements, 1915—Prepared under the direction of F. H. Peters, C. E., Commissioner of Irrigation, by R. P. Sauder, C. E., Chief Hydrometric Engineer, assisted by G. H. Whyte and N. M. Sutherland, Divisional Hydrometric Engineers. Ottawa, Canada: Department of the Interior. Paper; 7 x 10 in.; pp. v + 590; illustrated. 35c.

INDUSTRIAL COMMISSION: Annual Report for year ended Sept. 30, 1915—Albany, N. Y.: Department of Labor. [No. 56.] Cloth; 6 x 9 in.; pp. 417.

INSTRUCTIONS TO LOCATING ENGINEERS AND FIELD PARTIES—By F. Lavis, M. Am. Soc. C. E. Reproduced in abridged form from "Railroad Location Surveys and Estimates." New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 44; illustrated. $1 net.

INVESTIGATIONS OF GRAVEL FOR ROAD SURFACING: Official Publication of Iowa State College of Agriculture and Mechanic Arts, Dec. 10, 1916—By T. R. Agg, Highway Engineer. Ames, Iowa: Engineering Experiment Station. Bulletin 45. Paper; 6 x 9 in.; pp. 32; illustrated.

LETTERING FOR DRAFTSMEN, ENGINEERS AND STUDENTS; A Practical System of Freehand Lettering for Working Drawings—By Charles W. Reinhardt (former Chief Draftsman, "Engineering News"). Fourteenth Edition, Revised and Enlarged. New York: D. Van Nostrand Co. Boards; 8 x 11 in.; pp. 39; 15 plates. $1 net.

A LOGARITHMIC STADIA REDUCTION TABLE—By Francis S. Foote, Jr. Berkeley, Calif.: University of California Press. Vol. I, No. 11. Paper; 7 x 11 in.; pp. 281-292.

MANUFACTURE OF ARTILLERY AMMUNITION—By Members of the Editorial Staff of the "American Machinist": L. P. Alford, Editor in Chief; F. H. Colvin, E. A. Suverkrop, Robert Mawson, John H. Van Deventer. New York: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. xii + 765; 669 illustrations. $6 net.

MICHIGAN STATE HIGHWAY COMMISSIONER—Report for Two Fiscal Years Ended June 30, 1916—Lansing, Mich.: Frank F. Rogers, State Highway Commissioner. Paper; 6 x 9 in.; pp. 140; illustrated.

MICROSCOPIC EXAMINATION OF STEEL—By Henry Fay, Ph. D., D. Sc., Professor of Analytical Chemistry, Massachusetts Institute of Technology; Consulting Metallurgist, Watertown Arsenal. First edition. New York: John Wiley & Sons, Inc. Cloth; 6 x 9 in.; pp. 18; 56 illustrations. $1.25 net.

THE NATURAL PURIFICATION OF WATER BY FREEZING—By H. A. Whittaker, Director, Division of Sanitation. St. Paul: Minnesota State Board of Health. Paper; 6 x 9 in.; pp. 3.

On conditions governing safety of ice supplies; with five conclusions.

NEW JERSEY MUNICIPAL STATUTES: Report of the Commission To Revise and Codify the Statutes Relating to Cities and Other Municipalities. Trenton: The Secretary of State. Paper: 6 x 9 in.; pp. 354.

OIL INVESTIGATIONS IN ILLINOIS IN 1916—Under direction of Fred H. Kay. Work in coöperation with United States Geological Survey, State Geological Survey, and University of Illinois. Urbana, Ill.: State Geological Survey. Bulletin No. 35. Paper; 7 x 10 in.; pp. 80; illustrated.

PROCEEDINGS AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION, INC.: Report of Annual Convention, 1916—Atlantic City, N. J.: The Society. Cloth; 6 x 9 in.; pp. xlviii + 846; illustrated.

PROCEEDINGS MASTER CAR BUILDERS' ASSOCIATION: Report of Annual Convention, 1916—Atlantic City, N. J.: The Society. In two parts. Cloth; 6 x 9 in.; pp. xlvii + 1168; illustrated.

PROCEEDINGS OF THE EIGHTH NATIONAL CONFERENCE ON CITY PLANNING, Cleveland, 1916—New York: Nelson P. Lewis, Vice-Chairman. Cloth; 6 x 9 in.; pp. vi + 275.

PROPOSED SPECIFICATIONS FOR FIRE HOSE AND REPORT THEREON, January, 1917—Rochester: Bureau of Municipal Research, Inc. Paper; 6 x 9 in.; pp. 23.

Drawn by the bureau named, to meet the claim of a representative of a fire-hose manufacturer, who urged that the old specifications were closed ones, which precluded more than one manufacturer from bidding. The specifications were adopted by the Board of Contract and Supply, since which it appears that competition has been secured.

PUBLIC ENGINEERING AND HUMAN PROGRESS—By Morris Llewellyn Cooke, Consulting Engineer, Philadelphia. Presented before the Cleveland Engineering Society, Nov. 14, 1916. Paper; 6 x 9 in.; pp. 15.

PUBLIC SERVICE COMMISSION, SECOND DISTRICT, NEW YORK: Abstracts of Reports of Corporations, 1915—Albany, N. Y.: Public Service Commission. Cloth; 9 x 12 in.; pp. vii + 304; illustrated.

QUARRY ACCIDENTS IN THE UNITED STATES During 1915—Compiled by Albert H. Fay. Washington, D. C.: Bureau of Mines. [Technical Paper 165.] Paper; 6 x 9 in.; pp. 77. 10c. from Superintendent of Documents.

RIVETED BOILER JOINTS: A Treatise on the Design and Failures of Riveted Boiler Joints, with Numerous Original Diagrams Enabling the Designer To Design any Desired Joint Without Calculations—By S. F. Jeter, Member of Boiler Code Committee, Am. Soc. M. E. New York: McGraw-Hill Book Co., Inc. Cloth; 11 x 8 in.; pp. ix + 155; 52 illustrations. $3 net.

SEWAGE DISPOSAL FOR VILLAGE AND RURAL HOMES: Official Bulletin of Iowa State College of Agriculture and Mechanic Arts, Aug. 10, 1916—By C. S. Nichols. Ames, Iowa: Engineering Experiment Station. Bulletin 41. Paper; 6 x 9 in.; pp. 31; illustrated.

SEWAGE TREATMENT BY AËRATION AND ACTIVATION—By George T. Hammond, Engineer of Design and in Charge of the Sewage Experiment Station, Bureau of Sewers, Brooklyn, N. Y. Reprinted from the "Proceedings" of the American Society of Municipal Improvements, 1916. Paper; 6 x 9 in.; pp. 101; illustrated.

A comprehensive review of this promising new method of sewage treatment, based on personal investigation at many of the large-scale experimental plants and correspondence with those in charge of other plants.

SPECIAL COMMITTEE ON PUBLIC UTILITIES: Report of General Assembly of Illinois, Together with a Draft of a Bill To Provide Local Control of Public Utilities in Chicago, Jan. 20, 1917—Chicago, Ill.: The Commission. Paper; 6 x 9 in.; pp. 29.

SPRAY IRRIGATION—By Milo B. Williams, Irrigation Engineer. Washington, D. C.: United States Department of Agriculture. Bulletin No. 495. Paper; 6 x 9 in.; pp. 40; 19 illustrations. 10c. a copy from Superintendent of Documents.

THE STABILITY OF ARCHES—By Ernest H. Sprague, A. M. Inst. C. E. London: Scott, Greenwood & Son. New York: D. Van Nostrand Co. [The Broadway Series of Engineering Handbooks. Vol. XX.] Cloth; 5 x 8 in.; pp. viii + 141; 58 illustrations. $1.25.

STATISTICS OF COMMON CARRIERS: A Preliminary Abstract for the Year Ended June 30, 1916—Washington, D. C.: Interstate Commerce Commission. Paper; 9 x 12 in.; pp. 237.

STEAM BOILERS, THEIR THEORY AND DESIGN—By H. de B. Parsons, M. Am. Soc. M. E., M. Am. Soc. C. E., Professor Emeritus of Practical Engineering, Rensselaer Polytechnic Institute. Fifth edition. New York and London: Longmans, Green & Co. Cloth; 6 x 9 in.; pp. xvii + 377; 157 illustrations. $4 net.

TOPICOS TECHNICOS—By Ing. Octavio A. Acevedo. Santo Domingo, R. D.: The Author. Paper; 6 x 9 in.; pp. 114.

The book contains nine short papers, in Spanish, including El Mapa de la Republica—Informe Oficial Acueducto de San Pedro de Macoris, and Problemas Capitalenos—Acueducto, Cloacas y Pavimentacion.

TRACÉ SANITAIRE DES VILLES (Technique Sanitaire Urbaine)—By Dr. F. Saturnino Rodrigues. Paris: Imprimerie Chaix. New York: American Trading Co. Paper; 6 x 9 in.; pp. xiv + 128; illustrated. 10 francs.

An essay on city planning, with special reference to hygienic and sanitary conditions and to Brazil.

THE TREND OF LEGISLATION FOR PUBLIC HEALTH—By Arthur Connors. Indianapolis, Ind.: Indiana Bureau of Legislative Information. Bulletin No. 9, December, 1916. Paper; 5 x 7 in.; pp. 38.

UNIFICATION OF LOCAL GOVERNMENTS IN CHICAGO: Report Prepared by the Chicago Bureau of Public Efficiency—Paper; 6 x 9 in.; pp. 98; illustrated.

A sequel to a report by the same bureau in 1913 entitled "The Nineteen Local Governments in Chicago" (now increased to 22). The present report is designed to show the need for more complete unification and to present a simple plan of organization calculated to produce greater efficiency from public officials.

UNIFIED ACCOUNTING METHODS FOR INDUSTRIALS—By Clinton E. Woods. New York: The Ronald Press Co. (20 Vesey St.) Leather and cloth; 6 x 9 in.; pp. xvi + 484; illustrated. $5 postpaid.

WATER-POWERS OF MANITOBA, SASKATCHEWAN AND ALBERTA—By Leo G. Denis, Hydro-Electric Engineer. Ottawa, Ont.: Canada Commission of Conservation. Also additional data respecting Water Powers of Southern Manitoba and Bow River by J. B. Challies, M. Can. Soc. C. E., Superintendent, Water-Power Branch, Department of the Interior. Cloth; 6 x 9 in.; pp. ix + 334; 40 illustrations, maps and diagrams.

WEIGHTS AND MEASURES: Eleventh Annual Conference of Representatives from Various States Held at the Bureau of Standards, Washington, D. C., May, 1916, with appendix giving specifications adopted by the Conference and recommended by the Bureau of Standards for adoption by the several states, and appendix giving paper on Liquid-Measuring Pumps, by F. S. Schlink—Washington, D. C.: Bureau of Standards. Paper; 7 x 10 in.; pp. 193 + 43 + 27. 35c. per copy from Superintendent of Documents.

Notes from Field and Office

Clearing ditches and dressing slopes with crane and grab—Cement gun lines old tunnel—An adding machine in an engineering office—Discussion of errors in ordinary stadia work

Ditching Track with Crane and Grab Bucket

Clearing ditches and dressing the slopes of cuts by means of an "auto-crane" that travels along the tops of the cuts are interesting features of improvement work on the eastern division of the Pennsylvania Lines (Pittsburgh, Penn., to Crestline, Ohio, 188 miles). The railway company has a ditching machine that travels on the main track; but its use interferes with traffic, and work must be interrupted frequently while the machine gets clear of trains. A contract for the work was let to Laidlaw Brothers, of Pittsburgh, who use the equipment noted above and thus work independently of the railway traffic. The accompanying view shows the ditching outfit at work.

DITCHING WITH AUTO-CRANE AND GRAB BUCKET; PENNSYLVANIA LINES

The machine is an auto-crane built by the John F. Byers Co., of Ravenna, Ohio. It has a hoisting engine and boiler on a steel frame that also carries a headframe, mast and boom. The frame is mounted on broad-tired wheels, which travel on the ground or on plank runways. The machine is self-propelling, by means of chain drive to the two wheels at the crane end, and for heavy side lifts it can be braced by an inclined outrigger fitted to the top of the headframe and having a jack attached to its foot. There are two interchangeable booms, 18 ft. and 28 ft. long, and a narrow ½-yd. Owen bucket is used for ditching. The total weight of the outfit (including bucket) is about 12 tons.

The ditching has been completed for about 10 miles, on both sides of the track, and the average excavation is 400 cu.yd. per day. The short and long booms are used for light and deep cuts respectively, and the ditching has been done in cuts as deep as 60 ft. The material is deposited along the top of the cut, but can be loaded for removal if desired.

With the machine are an engineman or runner, a fireman, a helper and a team driver. They have a wagon for hauling coal and a tank wagon for bringing water from the nearest stream. Coal is supplied by the railway, which delivers it in piles ahead of the work. One man works with the bucket to spot it in position; two men with mattocks and shovels and a templet (1 on 1½) follow to trim, or "sandpaper," the slope. There is also a man to level off the spoil bank as the material is dumped from the bucket. A line is stretched to show the track side of the ditch, and the grade is kept by measuring from the rail.

Sometimes the machine works along the foot of the slope, if there is plenty of room; but usually it travels along the top of the cut. In moving from one cut to another it travels ordinarily under its own power. Where the right-of-way is very rough, however, the railway company furnishes a wrecker or derrick car that picks up the machine, swings it over the track and carries it (not loaded on a car) to the new site, depositing it in position to resume operations at once.

The ditching work is under the direction of E. B. Taylor, Jr., Division Engineer, Pennsylvania Lines, and E. G. Johnson, Assistant Engineer, at Pittsburgh, Penn.

Lining an Old Railway Tunnel with Concrete from Cement Gun

The Illinois Central R.R. has near Unionville, Ind., a single-track tunnel 506 ft. long, driven through shaley limestone. This was hard when freshly exposed, but disintegrated on exposure to the air and to moisture. As a result the stone was continually flaking off the sides and roof. Constant watching was necessary, especially as the action would occasionally release a boulder and there was always danger of accident. Estimates were made for a solid concrete lining; but as the tunnel section had grown to considerable proportions, the cost would have been large, while it would have been difficult to do the work without interfering with traffic.

Under the conditions it was decided to use the cement gun to apply a lining that would seal up all cracks and, by excluding air, moisture and locomotive gases, prevent any

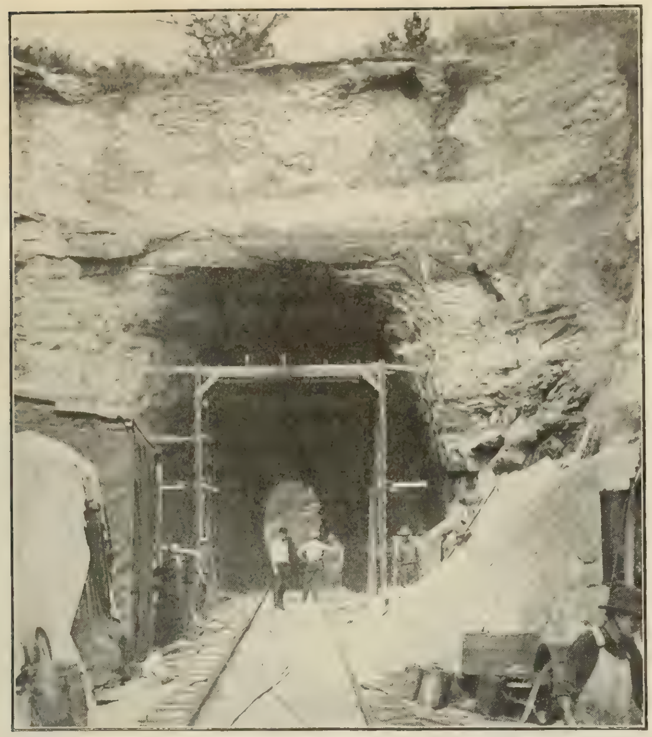


FIG. 1. ERODED ROCK TUNNEL WITH EQUIPMENT IN PLACE FOR LINING

further deterioration of the rock surfaces. The contract was let to the Cement-Gun Construction Co., of Chicago, for the entire work, which was carried out with satisfactory results. Information and photographs have been furnished by that company.

Fig. 1 shows the west end of the tunnel, with equipment (at the right of the portal) in position to start the work. The compressor was a little farther away from the portal, as shown at the right. A light timber gantry was erected for the use of the men at work on the lining. This gave sufficient side and top clearance to offer no obstruction to passing trains and was mounted on six rollers, so that it could be run on a temporary plank track.

FIG. 2. BLOWING CONCRETE ONTO WIRE NETTING SECURED TO THE FACE OF THE ROCK

The finished surface will be noted at the lower left-hand corner

The interior surface of the tunnel was very irregular, deep cavities alternating with projecting boulders. The average height was 26 ft. and the average width about 22 ft. The surface of the rock was first thoroughly cleaned by chipping off all defective stone and cutting away projecting points. Holes were then drilled, spaced about 30 in. each way, into which track spikes were driven. To these spikes was secured wire mesh, placed so as to follow the contour roughly, without any attempt to get even lines. Through this wire mesh, mortar was shot with the cement gun, as shown in Fig. 2. The lower left-hand corner of the picture shows some of the surface of the work as it appeared when completed. The wire mesh was pressed into the larger cavities and across smaller ones, so that small holes were shot full of gun-crete. After completion of the lining, portals of ordinary poured concrete were built at both ends.

The concrete consisted of a $1:3\frac{1}{2}$ mixture of portland cement and clean sharp sand. This was mixed dry before being placed in the cement gun, water for hydration being added at the nozzle in the usual manner. An air compressor driven by a fuel-oil engine furnished approximately 200 cu.ft. of free air per minute and used about 1 bbl. of fuel oil per 9-hour day. The work was started about Sept. 1 and finished early in October, 1916. There was an average of 10 trains per day through the tunnel, and the entire work was done without interference with the traffic.

Various Uses for Adding Machines in Engineering Offices

By Edwin S. Fuller*

The work of many engineering offices involves so much addition that it becomes necessary to purchase an adding machine. In most such offices the machine is used only for addition and stands idle a large part of the time. The writer has found the adding machine valuable for much work outside of the limited field of straight addition. A few special cases will be described as a suggestion of the possibilities.

The Adding Machine as a Tabulating Typewriter

The Water-Supply Papers, in which the United States Geological Survey publishes the results of its streamflow investigations, contain among other things tables showing the gage height and discharge of a large number of streams for each day of the year. For convenience in computing and filing, the office forms are arranged with parallel columns for gage height and discharge, but for the published reports separate tables of gage height and of discharge are prepared.

The preparation of the printer's copy of these tables has always been something of a problem. For some years manuscript tables were prepared by making two blueprints from the original double form, crossing out with a colored pencil the discharge figures on one print and the gage-height figures on the other. This resulted in a bulky, shabby-looking manuscript, and there were frequent typographical errors due to poor copy. To improve the copy, it became necessary to make a negative from the original double form and two black-line prints,

*Hydraulic Engineer, Washington, D. C.

crossing out with colored pencil as before. This relieved a part of the eyestrain for the typographer, but did not improve the original long-hand figures nor the looks of the manuscript and resulted in a greatly increased cost.

The writer suggested the use of some form of type-printing machine for the preparation of these tables and was authorized to investigate the matter. Various forms of typewriters were first tried out, but were found not entirely satisfactory. The adding machines already in the office were then tried, and it was found that these tables could be made by anyone familiar with the use of an adding machine in much less time than was required by an expert operator on a tabulating typewriter.

The computation of the data on the double form involved the addition of the daily discharge figures for each month; and this addition was made on the printer's copy instead of on a list as formerly, so that the only work required for the preparation of these two tables consisted of tabulating the daily gage heights on the adding machine, an operation requiring about 10 min. In this way it was possible to prepare neatly typewritten printer's copy at a cost less than one-fourth that of the former unsatisfactory copy, and the new method has now been generally adopted by this organization.

On large irrigation projects, where a record is kept of the amount of water delivered to the water users, the tabulation of these figures involves a large amount of work. By tabulating the ditch-riders' reports on an adding machine the time required may be materially reduced, and more legible tables result. Also, the addition involved in the computation of results may be carried on at the same time the figures are being tabulated, thus saving one complete step.

Use for Multiplying and Dividing

The adaptability of the adding machine to multiplication is not generally realized. By treating any multiplication as a series of additions the exact product of any two numbers may be readily obtained on an adding machine[1]. The capacity of a nine-bank adding machine is as great as that of seven-place logarithms, and even on an eight-key machine a skilled operator can compete successfully with a user of logarithm tables. The construction of the ten-key adding machines is such that they are especially adapted to multiplication, and the use of long-hand multiplication, tables of products, or logarithms, can be entirely eliminated to advantage in offices equipped with such machines.

The process of division can be accomplished on any adding machine to advantage by the use of reciprocals. The intelligent use of significant figures is essential if adding machines are to be used to best advantage in computation. For a very large part of engineering computations not more than four or five significant figures are required in the results, and this makes the adding machine especially adaptable to this class of work.

A complete table of four-place reciprocals from 1 to 1000 may be readily tabulated on the machine itself and posted in front of the operator. In many engineering offices the character of the computations is such that a limited number of reciprocals and constants is used repeatedly. These may be tabulated and posted in front of the operator, but it will be found that they are involuntarily memorized by the computer, who soon uses the machine almost automatically.

The work of the Government office above referred to involves the computation of mean monthly values for each of the rating stations for which data are published. These computations have been made with the aid of tables of products and conversion tables, and many of the computers have developed great speed in the use of these tables. The writer has found, however, that these computations may be made more quickly and with less effort on the ten-key adding machine, using a few easily memorized multipliers.

In building appraisal it is customary to compute the cost of buildings on the basis of a unit cost per square foot of floor area or per cubic foot of volume. The computation of floor area or cubic contents of a building involves both multiplication and addition. In the recent building appraisal of Los Angeles County, tables of products were used, these tables giving the area of the rectangles into which the floor areas were divided. It was found that the computations could be made at much greater speed and with much less effort on the adding machines, which had previously been used only for straight addition, and that the extensions involved in applying the unit price and the depreciation factors could be carried out as a step of this computation instead of as a separate step.

Accuracy and Speed

The accuracy attained by adding-machine operators is remarkable. In a top-speed test observed by the writer between computers on two different types of adding machines on a test involving some 5000 multiplications, only three errors were made by the two operators.

The greater use of the adding machine, when adapted to all the work in an office, results immediately in the production of skilled operators whose speed on ordinary addition will be found to have increased materially. The mental strain in operating an adding machine is almost nothing; and where electrically operated machines are used, the physical strain is very slight. It has been the writer's experience that the average clerk or computer will tend to maintain a higher efficiency when working on an adding machine than when doing any other form of office work, and the momentum gained in the increased use of an adding machine invariably results in improving the general tone of the office work.

[1]See "Engineering News," Oct. 7, 1915, p. 703.

Methods and Accuracy of Results of Transit and Stadia Topography

By Cyrus Townsend Brady, Jr.*

For line surveys always, and for other work with inexperienced men, the writer considers the transit and stadia method preferable to any other. It is understood that the resulting map is to be plotted to the usual scales of from 400 up to 1000 ft. to the inch—that is, 1 : 4800 to 1 : 12000.

One important advantage comes from only one man being needed besides the rodmen. In many cases (depending on wages, etc.) it is more economical to put two parties in the field, when two surveyors are available, rather than to use them as instrumentman and recorder.

*United States Steel Products Co., Buenos Aires, Argentina, S. A.

Another advantage is the ability to work in unfavorable weather and in woods or tall grass and bushes, where the plane-table is cumbersome to handle or difficult to protect from tearing or wetting of the paper.

The method has two disadvantages: It is not possible to make sure that "holes" have not been left in the topography before plotting the map, and the sketches made in the field and the side shots are often insufficient for accurate drawing. The first objection at least can be met by plotting the principal lines before leaving the field; and by inspection any doubtful areas will be noticed.

This plotting of the lines brings up a great advantage of the method: The traverse is plotted from calculated coördinates; and if closed or controlled by precise points, errors are easily distributed. Work on the plane-table is affected not only by stretching of the paper, but also by natural errors accumulating at the checking points, frequently so large as to require objectionable distortions of the mapping or even a redrawing in the office, in which case the expense is increased.

How To Deal with Errors in Stadia Work

The presence of errors must always be recognized, as stadia traverses are apt to give deceptive appearances of accuracy. On a certain 8000-hectare survey a traverse 45 km. long with 150 sides closed to 0°1′ of azimuth and a computed error of 1 to 4500. Although the stadia constant had been carefully determined on the ground and all ordinary pains taken in running the line, the actual error (ascertained by checking on two geodetic points) was over five times as great as that computed. This line is typical of many others. Hence, where the expense is not unduly high, stadia lines should close on others of superior accuracy, even if determined only by a more careful stadia traverse run for the purpose.

The unavoidable errors are so great that it is almost never worth while to apply to side shots the focal length and horizontal distance corrections for vertical angles under 5°. For traverse distances more care may be needed, and the following hint should be remembered: When the wires are not set correctly (that is, the constant is not 100), a little table should be made out showing the corrections plus or minus, to be applied to the observed intercept for every 50 ft. of distance. This correction should include the focal length. For instance, at 800 ft., if the table shows a correction of —3 ft., and an intercept of 8.11 ft. is observed, the true distance will be 808 feet.

The general procedure for mapping areas up to 100,000 acres may be as follows: The positions of the towns are determined by triangulation and traverses run along the roads between them, taped for distances over 6 or 8 miles and measured by stadia if shorter. The topography is then taken by the most suitable method, running parallel lines not over ½ mile apart even in quite open country, closing on points of the road traverses. The elevations are controlled by levels along the roads, but it is not usually necessary to turn on the traverse points oftener than every two or three miles.

A Case of Quick Stadia Work

Recently the writer made an investigation for a pumped water-supply in the treeless hilly country in the southern part of the Province of Buenos Aires. The distance was about 5 miles; and as it was of course essential to know the difference of elevation, etc., a stadia line was deemed necessary. The afternoon before the day of the survey, four rods were made by a local carpenter. A height of 12 ft., instead of the 14 ft. usually convenient, was chosen on account of the extremely high wind blowing.

In spite of the violent wind and the untrained men—none of whom had ever seen a stadia rod—the line was run between 7 a.m. and 3.30 p.m. Twenty-three stations were occupied, and 60 side shots (including several triangulation shots) were observed. No plumb bob was used, and the stations were merely crosses marked in the earth or on the rocks, over which the instrument was set by eye. Ample sketches were made, and a map was plotted to a scale of 800 ft. to the inch (1:9600), showing a belt of topography 2000 ft. wide. The accuracy was quite sufficient for locating a pipe line; and if some horizontal and vertical control had been obtainable, the map would serve for more important constructions.

This was the first time in many years that the writer had made a survey in feet (the work was done for a new American enterprise whose officers are not yet familiar with metric measurements), and it was only the more convincing of the superiority for topographic work of the metric system. For elevations the decimeter (0.33 ft.) is a far better unit than 0.1 ft., and for distance the metric graduations are much easier to read and to count than feet.

In flat open country the writer has frequently used the following party: One man to carry instrument, one man to carry large umbrella and lunch, etc. (in hot weather), six stadia men (one back flag, one fore flag and four for side shots), sometimes headed by a foreman to keep in advance of the fore flag, picking points, etc., although this man is more useful when woods are encountered, in which case two side-shot men are replaced by axmen. With this party, which it will be noticed does not contain a recorder, the author once surveyed 3000 hectares (7500 acres) to the scale of 1:10,000 in one week; this was of course only possible by means of the control traverses and levels run along the main roads the week before.

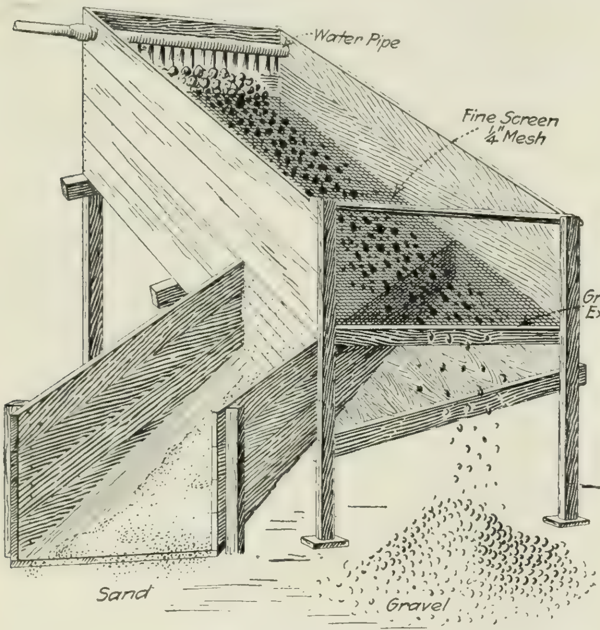
In conclusion the writer would like to state that the best rodmen he has had in the Philippines and in South America have been local common laborers—after a day or two of experience. In the first place the work of tramping over hills seems to them an easy thing, and the newness and strangeness enhance the interest of the work and lend them an importance in the minds of their friends which tends to make them do their best. They have never any preconceived notions of how the rod should be held, nor does the back flag assume that you are through with him and sit down. Above all, they know local names, etc., and—*verbum sap*—in which fields savage animals are kept.

FINE AGGREGATE

Problem in Retracing Old Survey—A tract of land was laid out in 1791 in the course of subdividing a larger tract. Lying on the top and slopes of a rocky mountain, the tract was never fenced. The original corners have disappeared. The northerly boundary lies in a division line several miles in length and is marked by fences and old walls on either side of the tract in question. The northerly boundary can therefore be

reproduced approximately. The sides of the tract, by description, make right angles with each other—that is, deducing the angles from the bearings. It is desired to reproduce the easterly boundary. Local surveyors say that, having allowed for the change in magnetic variation between 1791 and the present time, the northeast corner of the tract having been located, the proper procedure is to run the boundaries as needle lines. In other words, the direction is taken from the needle at each set-up. They claim that by so doing they are able to reproduce the line of the original survey. To this claim several objections may be raised: (1) Even allowing that the original needle pointings can be reproduced, unless the lengths of the different courses of the original survey are used, the resulting series of lines will be parallel to the original series, but not coincident; (2) it is not possible to reproduce the original needle pointings, on account of the daily variation of the needle and the variation due to different electrical conditions of the atmosphere. Since the field notes of the original survey are not available, the lengths of the different courses of the boundary and the hour of the day when run cannot be known. Why not run a straight line from the northeast corner, at right angles to the north boundary, for the east boundary, instead of the devious needle line, with an angle at every instrument point?—G. M. B.

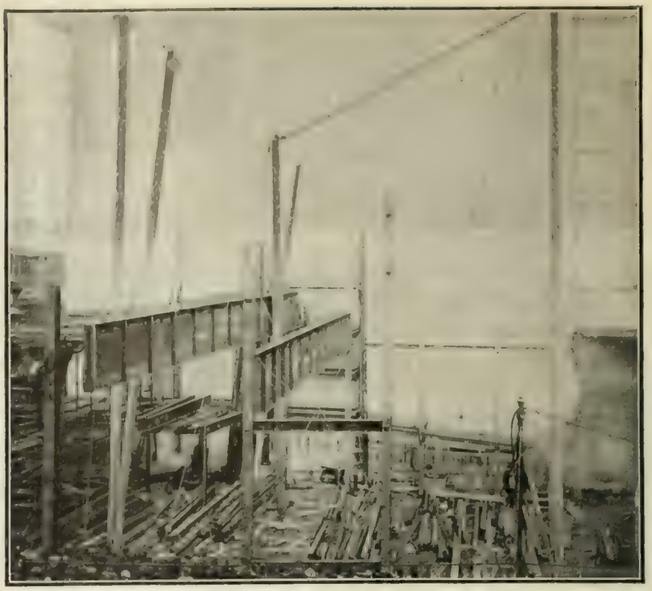
Small Screen and Washer—Frequently the material in a sand-and-gravel pit is first class, but the percentage of loam is too high and the proportion of sand to gravel is not right—requiring screening and washing. The device here illustrated is recommended for this purpose. It consists of a chute slanting at least 45°. A hillside is the best location; otherwise a platform should be constructed, to accommodate teams. The bottom of the chute slants to one side; this and a board nailed across the chute at the lower end deflect the sand to one side and keep it out of the way of the gravel, which comes straight down the chute. A fine screen placed about 12 in. below the top of the chute separates the gravel from the sand, while a pipe drilled with a row of small holes, staggered, delivers water that washes the loam from the sand



CONVENIENT DEVICE FOR WASHING AND SCREENING SAND AND GRAVEL

and helps in the screening. One of these devices was used with success on a large concrete job of which the writer had charge. Material containing 20% loam was passed over, coming out with less than 2%. The device should be located at the mixer, and plenty of water should be forced through the pipe. Two men can easily keep a 1-yd. mixer supplied.—G. M. Gilkison, 212 Highland St., Syracuse, N Y

Large Girders in San Francisco Theater—The two plate girders shown in the view are $8\frac{1}{2}$ x 88 ft., weigh 35 tons, were fabricated in one piece and are said to be the largest assembled girders ever used on a building on the Pacific Coast. They support the balcony of the California Theater, in San Francisco, and were lifted $36\frac{1}{2}$ ft. in 12 min. by two wooden guy derricks of special design. The derricks are made of 24 x 24-in. Oregon fir and have 90-ft. masts and 85-ft. booms. Both masts were anchored by ten $1\frac{1}{2}$-in. cables to concrete piers. Two cast-steel dogs, each weighing 250 lb. and fas-

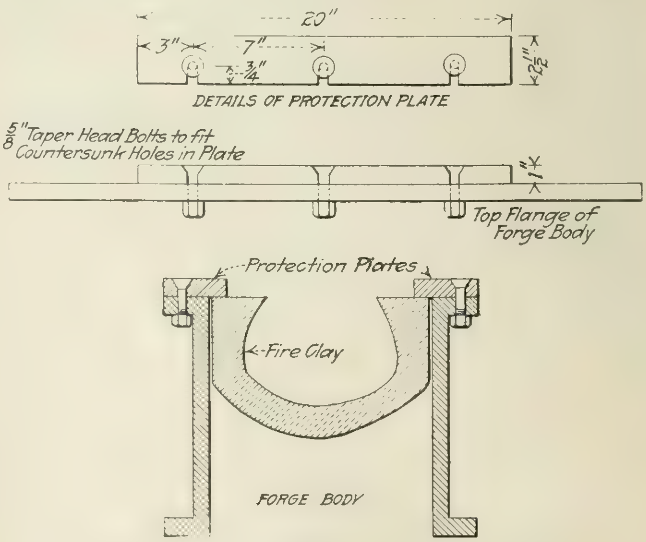


TWO 35-TON GIRDERS HANDLED BY SPECIAL DERRICKS, IN SAN FRANCISCO

tened to seven 1-in. steel cables, composed of eight strands of 19 wires each, were used to clamp and lift the girders and hold them in position until fastened to the 14 x 14-in. columns by means of drift pins, which latter were speedily replaced by $\frac{7}{8}$-in. rivets—78 on each end. The girders were fabricated by Jones & Laughlin, Pittsburgh, and were erected by the Dean Construction Co. under the supervision of J. J. Rosenthal, safety engineer, Industrial Accident Commission of California.

Careless Use of Small Electric Devices such as pressing or curling irons, toasters, electric pads, plate warmers and sterilizers has grown to sufficiently serious proportions to warrant the publication of a bulletin by the National Board of Fire Underwriters, 76 William St., New York City. Fires resulting from this form of carelessness are usually small, but the aggregate loss is large. The actuarial bureau of the board reports 100 such fires out of a total of 2000 losses in the day's report, and estimates that small electrical devices are causing 30,000 fires in the course of a year. Such fires are preventable.

Protecting a Clay Drill-Forge from damage resulting from dragging the bits in and out of the fire is done in the steel-sharpening shop of the Wisconsin Zinc Co., Platteville, Wis., by bolting 1-in. steel plates to the flange of the forge body, as shown in the sketch. The forge is of the oil-burning type made by the Denver Fire Clay Co., and has capacity for nine bits. According to J. E. O'Rourke—whose drill-sharpening article won a first prize in the recent "Engineering News" Contest—these plates protect the fireclay lining of the forge from damage.



PROTECTION PLATES FOR OIL FORGE

Editorials

Rendering Service to the Entire Engineering Profession

The consolidation of the Hill Publishing Co. and the McGraw Publishing Co., announced in *Engineering News* of Mar. 1, is an event of such importance and interest to the whole engineering fraternity that some comment upon it, and upon the process of evolution in the publishing business which has brought it about, is appropriate in this place.

In the consolidations which have gone on in manufacturing and commercial industries during the past twenty years, the governing motives as a rule have been the desire to eliminate competition with its attendant wastes, and, by capitalizing earning power, to sell properties to the public at a large profit.

Consolidation in the technical publishing field has come about through quite other causes. First among the influences which have tended to bring about consolidation have been printing office conditions. It can readily be understood that a single weekly journal cannot run its own printing office economically, for a plant and working force big enough to handle a weekly issue promptly on press days would be idle most of the week, except as it might enter the general competition for job printing to keep itself employed. In order that a publisher may conduct his own printing office—and there are many advantages in having full control of the printing operations—he is almost forced to issue a number of journals rather than one, in order to keep his printing costs on a reasonable level.

Again, what are generally termed overhead expenses may obviously be made less in a large organization than in a small concern issuing only a single publication. The advantages in capital, in security of investment, and in prestige are also all on the side of the large organization.

While these and similar considerations sufficiently explain the causes which have led to various publishing consolidations during the past dozen years, what is of most interest to the reader of engineering journals is the effect on the quality of service rendered.

If consolidation meant—as it has sometimes meant in commercial circles—that the public would be obliged to pay higher prices for goods or would receive poorer service, there would be good ground for protest. But in the publishing business more than in any other, the item of Good Will is not a mere generality of the accounting department but an actual asset, on which, in fact, the value of all the other assets depend. Any publishing enterprise which does not exert itself to render such a service to its subscribers and advertisers that it can retain their Good Will is headed for bankruptcy, no matter how large its capital or how distinguished its history.

Merely as a matter of sound business policy, in this as in any other consolidation of publishing interests, the management is bound to see that the new organization maintains at least the record of the old in service to its patrons. But the matter does not stop here. Those responsible for creating the McGraw-Hill Publishing Co., Inc., have behind them a long record of high achievement as publishers of the best in engineering journals. Their standards have not been the standards of the old-time trade journal, which was run as a purely commercial enterprise. They have aimed to make their journals leaders in their respective fields in promoting good practice and equitable dealing. That is still their aim.

It is a fact worth record that Mr. Hill, the founder of the Hill Publishing Co., began his work in technical journalism as an editor and continued in editorial work for many years before going over to the business side. Mr. McGraw, the founder of the McGraw Publishing Co., began at the very bottom in technical journalism and built up his journals with keen attention always to the character of editorial service rendered. Mr. E. J. Mehren, on whom as Vice-President and General Manager rests the conduct of the consolidated company, is a civil engineer by profession, and in his years of successful work as Editor of the *Engineering Record* has demonstrated to a wide circle of engineers, not only his ability in the conduct of a great technical journal, but also his high ideals as to the position of leadership which technical journals should occupy.

The journals which the McGraw-Hill Co. publish cover the fields of Civil, Mining, Mechanical, Electrical, and Chemical Engineering. It is difficult to overestimate the value of the service which this group of journals is capable of rendering to the engineering profession.

A Problem That Is Always with Us

Building a permanent and unyielding foundation is something of an unsolved problem. The engineer's increasing skill in design ever improves the superstructure, just as the architect's planning develops ever new styles of buildings. Both engineer and architect base their planning on the premise that a rigid and stable substructure will be had, to carry their superstructure. Their assumption often is belied by the results, and the point of the matter is that this is just as often the case today as in the times of the medieval constructors.

"Every first-class abutment that is a few years old has some cracks," an engineer recently said in public discussion. He was making a gentle charge against foundation practice fully as much as against our limited knowledge of retaining-wall mechanics. Foundations settle, it is universally observed. But nobody has discovered, nobody has investigated, the factors determining this settlement. When and where we are to look for a settlement of $\frac{1}{4}$ in., when and where for a settlement of 2 in. or of 14 in., and how soon these settlements will develop—such questions have not yet been explored.

We know roughly that all soils are compressible and slightly elastic. We know that some soils show very marked viscous flow, and we suspect that all soils have plasticity in some degree, at least. Whether loading and the lapse of time will change a viscous soil to normal soil,

we do not definitely know. When pile foundations in the river silt at New York go down 3 or 4 ft. in the course of a couple of years, we are not able to explain the phenomenon nor can we predict it, except from identical experience in the identical soil. When the piles of a bridge foundation are pushed over by flow of near-by fill, as occurred last season at Baltimore, the condition again is one in which it is hard to predict, and hard to provide a certain cure. But the larger problem, because more commonplace, is that presented by ordinary good earth, as to whose load-carrying power and liability to settlement we have practically no figures—little more than some crude notions, enough to make structures safely stable, but not enough to keep them free from cracks.

We are in a sense at the threshold of development in this field of soil and foundation studies. What beginnings have been made are not promising; or, to state the fact more fairly, they have not yet shown a path by which the field can be explored. The mere fact, however, that superstructure knowledge has far outstripped substructure knowledge makes it certain that study must turn in the direction of the latter.

It is a satisfaction to contemplate the fact that engineering skill in constructing foundations has made great advances in the last quarter-century. This in itself gives some promise that we need not despair of mastering foundation soils. But for the present, earth foundations are a problem that is always with us.

Railway Traffic Congestion and Terminal Improvements

For fully a year now, there has been congestion in railway transportation over a considerable part of the United States. In previous years when railway congestion has occurred, the trouble has usually been diagnosed as "car shortage," railway officers themselves have been slow to understand that "car shortage" is often a symptom rather than a disease.

In the railway blockade of 1916-17, however, the public as well as the railway officials has learned that the inability of a shipper to secure cars may be due to much deeper causes than failure of the railway company to own as many cars as its business demands. In fact the present railway congestion has been a remarkable object lesson, showing how obstruction at one point in the country's transportation system can cause congestion extending for thousands of miles.

The flow of freight traffic over the railway system of the continent is closely analogous to the flow of a liquid in a network of pipes, like that supplying a great city with water. If the flow is interrupted at any point, the current becomes stagnant for a long distance back from the point where the obstruction is placed. Delay in unloading freight at Atlantic seaports has kept cars tied up which should have been immediately released for the return journey; has filled yards and sidings; has made necessary the establishment of embargoes extending to the origin of freight in the far West in order to prevent entire stoppage of traffic; has interfered with the delivery of food, fuel, and manufactured products to hundreds of cities and towns; has caused hundreds of industries to run on part time, even though their goods were in urgent demand by consumers; and has sent retail prices of food products soaring in many cities.

How many millions of dollars of losses have been caused by the railway congestion of the past year it would be difficult to conjecture; but the public has certainly had a remarkable lesson as to the truth of the oft-repeated warning that ample railway facilities are even more necessary to prosperity than low railway rates.

It is without doubt the congestion of the past year that has led to the present agitation in many cities for the improvement of railway terminal facilities. This agitation comes not from railway officials but from leading commercial interests. Particularly notable is the agitation for the construction of municipal belt line railways and their operation on a plan similar to that adopted on the New Orleans Belt Ry., whereby all railways alike have equal use of the system. At Boston recently members of the Commission on the high cost of living declared that the New Orleans belt line plan ought to be adopted by Boston and that opposition of the municipal authorities to plans of the New Haven to enlarge its terminals must cease.

At Philadelphia, Director George S. Webster of the Department of Docks recently returned from an inspection of the New Orleans belt line and is making plans for the development of Philadelphia's present belt line railway so that it may be equally important and efficient. At Cincinnati a question of leading public interest is whether the Trustees of the Cincinnati Southern Ry., which was built and is owned by the city, shall take the lead in building extensive freight and passenger terminals. At Baltimore, the Pennsylvania R.R. has renewed its negotiations with the city for municipal legislation that will enable it to spend some $15,000,000 to increase the capacity of its lines through the city and its freight terminals. At New York, where congestion has been worse than at any other point in the country, discussion is still proceeding over the long delayed project of the New York Central to spend some $50,000,000 in enlarging its freight terminals. Leading engineers are interested, also, in the project for developing the traffic facilities of the entire Port of New York, on the New Jersey side of the river as well as the New York side and establishing a Port Commission to have charge of the entire work.

What is going on in the cities above mentioned is typical of the agitation which is going on in many other cities. The rebuilding and enlargement of railway traffic terminals promises to be as important a field of engineering work for the next decade as was the building of main line railways a generation ago.

The Federal Flood-Control Law

The Flood-Control bill passed in the closing hours of the last Congress establishes a new policy in river regulation for the Federal Government. Heretofore, all the work done by the Government on river and harbor improvement has been ostensibly for the improvement of navigation facilities. While the Government has expended millions of dollars on bank revetment works and levees along the lower Mississippi, it has been justified on the theory that both the bank-protection work and the levees were for the purpose of maintaining the navigable channel.

By the new law the Government definitely assumes responsibility for the control of floods in the Mississippi and

Sacramento Rivers. It makes, however, no appropriation for this work. That is left to future Congresses. The law directs the Secretary of War to carry on continuously, by hired labor or otherwise, the plans of the Mississippi River Commission for controlling the floods of the Mississippi and continuing its improvement from the Head of the Passes to the mouth of the Ohio River, "to be paid for as appropriations may from time to time be made by law." It is also specified that expenditures are not to exceed $10,000,000 in any one fiscal year nor $45,000,000 in the aggregate.

Since the present law carries no appropriation, it is difficult to see how the work could be carried on by hired labor until appropriations are made by a later Congress. It would be possible perhaps to let contracts for the work, the contractor taking the risk that the next Congress will make the necessary appropriations to pay for his work, failing which he would have to resort to the Court of Claims.

The question as to what action can be taken under the law is complicated also by the failure of the River and Harbor appropriation bill to pass. This bill carried an allotment of $6,000,000 for the work of the Mississippi River Commission, including the building and protection of levees. If the commission had had this large fund available, it might have gone ahead making surveys, estimates, etc., preparatory to letting contracts for levee construction under the Flood Control law. Of course, this work would naturally be postponed anyway until after the season of spring high water is over. By that time the new Congress, if it is called, may enact a new river and harbor bill or make appropriations under the Flood Control law.

Still another complication with the Flood Control law is that the Mississippi River Commission is required to assess upon the "local interests protected" (which doubtless means the levee districts), such a contribution as the commission shall determine to be just and equitable, but which shall be not less than one-half the Federal allotment for the work. This means a delay until these assessments can be made upon the levee districts, and the districts can make arrangements to float bonds to raise the necessary funds.

Similar restrictions govern the flood-control work on the Sacramento River, except that on that river the State of California is required to contribute a sum equal to that allotted by the commission from the Federal appropriation.

The third section of the new law was apparently intended by its framer to make possible surveys for flood-control work by the Federal Government on other rivers than the Mississippi and Sacramento, in the same way that surveys are made for river and harbor improvements. As passed, however, the law does nothing more than lay down a general policy; it names no rivers on which surveys are to be made and makes no appropriation for such surveys. It is of interest to note, however, that the law does specify that, when such surveys are made (presumably in accordance with acts and appropriations made by future Congresses), the survey and report must give data on "the possible economical development and utilization of water power and such other uses as may properly be related to the project."

It is of course true that the acts of one Congress are not binding upon its successors. The Sixty-Fifth Congress, with its very different political complexion, may possibly do nothing whatever toward carrying out the policy laid down in the Flood-Control bill. On the other hand there is a growing public sentiment that the Federal Government should take the lead in carrying out large national engineering works and in regulating such a great interstate stream as the Mississippi. The flood-control work laid down in the new law may mark the beginning of a new era in Government work on river regulation.

At any rate it puts official ban upon the pleasant fiction of so many years standing that *all* work on navigable rivers is a Federal responsibility under the broad interstate commerce clause of the constitution. A proper distinction between navigation and regulation is at last recognized by Congress.

Engineers Should Fight Untrue "Costs"

There is a vast deal of untrue cost reporting in this day and generation. By untrue we mean simply incorrect, whatever the underlying cause or motive. Much of this untruthfulness is due to unintentional incompleteness through ignorance, blundering or laziness, but some is deliberately designed to deceive. Engineers, who value their reputation for scientific accuracy and for professional honesty, should fight untrue cost reporting, regardless of its origin or object.

Flagrant examples of untrue cost reporting are apt to be found after changes from private to municipal ownership of water-works and other public utilities. In such case it is very common for cities to claim profits under municipal ownership, sometimes after considerable reductions in rates, when the fact is that inadequate allowance, and in extreme cases no allowance at all, has been made for capital charges. Similarly, cities changing from street cleaning or garbage disposal by contract, will compare contract prices with the "cost" of the municipal service, and make absolutely no allowance for interest and depreciation on plant and equipment. An example of this occurred in the first statement of the results of the operation of the Cleveland garbage-reduction works under municipal ownership, although a footnote naïvely gave warning to the wary that interest on bonds was not included because it was taken care of by another city department. Later reports, it is only fair to say, included an allowance for all capital charges.

Engineers can appreciate the obligation of cities to include capital charges whenever comparing public with private ownership of utilities, or results under contract construction of sewers or pavements or contract service in street cleaning, garbage collection and disposal with force-account results. The average city official, however, seems unable or unwilling to take all the elements of cost into account when he is reporting the cost of almost any service rendered by a city. What city accounts, to go into quite another field than any of those mentioned, include in the statement of cost of the public schools the interest charges and depreciation on the investment in school buildings?

Since the engineer can and does appreciate all the elements of cost far better than the average city official or citizen he should take pains to see, each in his own city or state, that true and full costs are reported instead of dishonest or partial costs.

Letters to the Editor

"Rocmac" as a Pavement Foundation

Sir—Our attention has been directed to a note that appeared in "Engineering News," Jan. 18, p 116, quoting from a paper read by George C Warren, president of Warren Brothers Co., Boston, Mass., at the meeting of the engineering section of the American Association for the Advancement of Science, on Dec. 28, 1916. Mr. Warren stated that as the result of considerable investigation his company has found that a "Rocmac" foundation is entirely satisfactory for use under bituminous wearing surfaces. He stated further that his company has successfully laid approximately 10,000 sq.yd. of wearing surface over a foundation made of silicate of soda and crushed stone; and he has found that the silicate of soda or "Rocmac" concrete has greater resiliency and less rigidity than portland-cement concrete and apparently materially lessens, if it does not entirely overcome, the cracking troubles of portland-cement foundations.

In connection with this extract from his paper, the editor comments on the solubility of silicate of soda in water. He also comments on the fact that silicate has been used to some extent in road pavements under the trade name "Rocmac," which is a mixture containing sugar, powdered limestone and other ingredients.

In making this comment we fear that the editor has unintentionally made a statement that may give a wrong impression. In the first place, silicate of soda, while soluble in water, is dissolved with difficulty. Silicate is produced by melting sand and soda ash in a furnace similar to that used in the manufacture of window glass. The first stage is complete when the glass is drawn from the furnace and allowed to cool. To put this in solution form requires the use of quite an elaborate apparatus, and the glass is dissolved at a high temperature to whatever density of solution is required. On exposure to the air this solution parts with water by evaporation, and the silicate becomes very hard and very difficult to dissolve again under ordinary conditions. The foregoing is mentioned only parenthetically.

In the manufacture of silicate of soda a number of different grades are made, the quality being determined by the use to which it is to be put. After long experiment a special grade has been prepared for use in road building, and to this has been given the trade-mark name "Rocmac." In using it, "Rocmac" solution is combined with fine-ground limestone (carbonate of lime) and crushed stone. There is a series of chemical reactions which follow the combination, resulting in the formation of an insoluble cement, or matrix, that holds the crushed-stone aggregate securely in place.

We feel quite sure that your readers will be interested in this statement as a matter of information in regard to "Rocmac" roads. Sugar is not used in the combination at all, although patents have been taken out covering the theory of using sugar in the mixture.

WILLIAM TOWNSLEY,
General Manager, the Rocmac Co.

Cleveland, Ohio, Feb. 20, 1917.

[In the paper referred to, Mr. Warren did not mention "Rocmac" by name, and the reader had no reason for concluding that the silicate of soda concrete to which Mr. Warren referred was identical with "Rocmac." The definition of "Rocmac" given in the note under discussion is taken from a statement in the authoritative 1916 "Good Roads Year Book," p. 384.—Editor.]

More Light on Boston High-Pressure Fire-Service Controversy

Sir—Our attention has been called to the letter of the commissioner of public works, E. F. Murphy, of Boston, Mass., in "Engineering News," Feb. 22, in which he takes exception to statements concerning the high-pressure fire service in that city, which appeared in "Engineering News" of Jan. 11, in comment on a report by the National Board of Fire Underwriters.

You have adequately disposed of Mr Murphy's statement as to the 17 discharged employees, except that you might well have quoted further from the findings of the judge of the Dorchester Municipal Court: "I find that the underlying motive for the change was purely political, with the primary object of getting rid of these petitioners and other obnoxious employees . . ."

As is probably known to many of your readers, the "engineering inspector" mentioned in Mr. Murphy's letter is Clarence Goldsmith, whose qualifications include a degree from the Massachusetts Institute of Technology and membership in the three leading American engineering societies, civil, mechanical and electrical.

The position of engineer in charge of the high-pressure fire-service system was at no time sought by Mr. Goldsmith, nor for him by the National Board. In August, 1911, the then mayor of Boston approved his appointment upon recommendation of the then commissioner of public works, who had previously ascertained, largely by personal observation during a three months' study of conditions in Boston by National Board engineers, the qualifications of the appointee and his willingness to accept the situation. During the 2½ years following August, 1911, plans and specifications were perfected and much development and experimental work accomplished. At the time the first contract for pipe laying was about to be let, early in March, 1914, the present mayor refused to approve the certification necessary for Mr. Goldsmith's further employment.

The pipe-laying contract was let, and on June 5, 1914, the then commissioner of public works, with the approval of the present mayor, again sought the services of Mr. Goldsmith, who consented to return only with the understanding that he should be retained until the completion of the system and that work should be pushed rapidly. The position entailed long hours and much responsibility and could not, under the conditions then prevailing, be considered as congenial or desirable, nor did it afford any greater salary than Mr. Goldsmith had been receiving.

The work performed under the pipe-laying contract failed in many instances to meet the specifications, and in January, 1915, the engineer in charge sent a letter to the commissioner of public works, setting forth in detail the deficiencies in the work; a copy of this letter was filed with the Finance Commission of the City of Boston. Notwithstanding the advice contained in this letter, that no further work of this inferior nature be allowed, the same class of work was continued during the succeeding season. However, the engineer in charge refused (except in one instance) to approve any of the monthly estimates for payment on this contract. That his contentions were correct is proved by the amount of work his successor has had to do to make this part of the system satisfactory.

The only misstatement of fact brought to my attention, or of which I am aware, in our report of December, 1916, is that an allowable leakage of 4 gal. per lin.ft. of joint in 24 hours is about double that allowed on any similar system. The New York specifications allow 4 gal. leakage; but those for other similar systems allow considerably less, and, so far as we have been advised, it has been possible to secure satisfactory compliance with these specifications.

The statement to which Mr. Murphy objects was not made the basis for any criticism in our report, as we did not and do not now consider a maximum allowable leakage of 4 gal. per ft. of pipe joint high enough to be particularly objectionable. Much stress was laid on this misstatement, both in Mr. Murphy's letter and the public hearing to which he refers, with the evident intent to distract public attention from other and really vital parts of our report.

GEORGE W. BOOTH,
Chief Engineer, National Board of Fire Underwriters.

New York City, Mar. 1, 1917.

New Curb and Step Forms—The address of the maker of these forms, described in "Engineering News," Feb. 15, p. 296, was given as Cincinnati, Ohio. The correct address is the H. D. Cornelius Co., 3012 Calvelage St., Indianapolis, Ind.

Gates and Valves of the Elephant Butte Dam (correction)—The article in "Engineering News" of Feb. 22 stated that the transition castings of the penstock conduits were made by the Eddy Foundry Co., of Milwaukee, Wis. They were made by the R. M. Eddy Foundry Co., of Chicago, Ill.

Another Street Tunnel To Be Built in Los Angeles

By R. W. Stewart*

The long-discussed Second St. tunnel through "Bunker Hill," in Los Angeles, Calif., has at last been definitely authorized. Work on it will probably begin in two months.

The extension of suitable avenues of traffic through the hill which bounds the older business district on the north and west has long been a civic problem in Los Angeles. Streets passing over the hill to the west have grades of 11½% or more. In 1900 tunnels were bored at Third St. and Broadway, these being described in *Engineering News,* July 18, 1901, p. 35. The grades approaching the original Broadway tunnel being objectionable, it was underpinned in 1915, one end being lowered 20 ft. (*Engineering News,* Mar. 2, 1916, p. 414.)

Since the advent of the automobile the Third St. tunnel has been badly congested, and additional tunnels have been proposed for First, Second, Fourth and Fifth Sts. Two other projects which received serious consideration were (1) cutting down the entire hill west of the business district, and (2) opening a cut more than one block wide through the hill which would include First and Second Sts. and all abutting property.

The last mentioned cut, which was only a fraction of the first, would have been 90 ft. deep, involved the removal of 3,741,000 cu.yd. of earth through well populated surroundings, and required wrecking the buildings (some of which were high-class) which occupied a majority of the lots over the site of the cut.

Second St. tunnel has finally been selected as the most feasible step toward improving traffic conditions west from the city. On Feb. 7, 1917, the City Council passed the ordinance ordering its construction. Bids will be received on Mar. 26.

Work To Be Paid for by Assessment

The tunnel will be financed by special assessment on a large area comprising the northerly retail and wholesale district, and residential territory westerly thereof which is fenced off from the city by the hill.

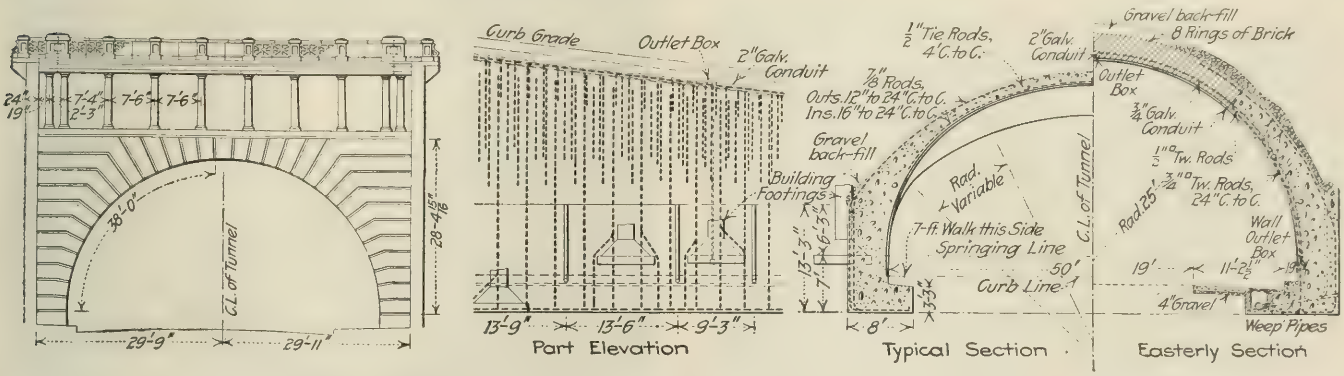
Second St. is 60 ft. wide; the tunnel will be 50 ft. wide in the clear. The greater part of its length will have a semicircular arch with the springing line 3 ft. above the roadway, this making the tunnel 28 ft. in height. To let Clay St. pass over the tunnel near its easterly portal its height is tapered down to 20½ ft. in a distance of 64 ft., the width at the springing line remaining constant. Near the center of the tunnel will be a slight angle. This is due to the necessity of following the lines of Second St., some property owners on the hill not having been willing to give easements under their lots and condemnation procedure being slow and unsatisfactory.

The tunnel will be lined throughout with white enameled tile and well lighted. Its principal structural features are as shown by accompanying figures.

The portal wall at the west end will be set back some distance on the barrel of the tunnel and will support one edge of a reinforced-concrete sidewalk slab whose other edge will be supported by a colonnade flush with the end of the tunnel. This will avoid great increase in foundation pressures at the end due to earth thrust against the portal. Both portals will be faced with artificial stone.

A new street detouring the easterly tunnel portal on its northerly side is being opened to give access to the top of the hill.

Damages will have to be paid to property owners fronting the approach cuts. The tunnel will cost about $800,000.



SOME DETAILS OF SECOND ST. TUNNEL AT LOS ANGELES, CALIF.

*Engineer of Bridges and Structures for the City of Los Angeles, Calif.

Chicago Subway Design Outlined

Design and construction of the proposed subways at Chicago are included in the Chicago Traction and Subway Commission's comprehensive report, which has recently been made public.

The State St. rapid-transit subway is to accommodate the elevated-railway trains and to form a north-and-south route through the congested district of the city. It will be about 3 miles long, from 18th St. to Chicago Ave. at Franklin St. The profile will follow that of the streets, except that 3% grades will be used for the connecting inclines at each end and for the approaches to the tunnel under the river.

The level of base of rail is about 18 ft. below the street. This provides for two-level construction at the intersections with surface-car subways and the future low-level crosstown rapid-transit subways. The tunnels of the Illinois Tunnel Co. have their arches about 33 ft. below the street, and this determines the elevation of tracks of the two intersecting subways above the tunnel. Except for this limitation it is stated that the

depth from street to base of rail should be at least 21 ft. This would simplify the restoration of subsurface structures and reduce the noise from surface traffic. On the other hand, the shallower construction reduces the amount of excavation and reduces the height of stairways.

The material encountered is such that great care will be required in construction to prevent movement and excessive drainage of adjacent ground. As the excavation will be below the shallow types of building foundations, such buildings must be underpinned or the trench inclosed by water-tight sheeting to sustain the lateral pressure of the saturated earth and clay. For the low-level street-car subway the depth of trench would be about 33 ft., but it is believed that the subways can be built without damage to the streets or building. It is pointed out that the subsoil conditions are quite different from those in other cities where subways have been built.

The report states that in the business streets it is proposed to carry on the subway construction beneath a deck of heavy planking that will temporarily form the street surface. The work would be done in short sections, so as to avoid long stretches of excavation. For the low-level subway a similar method is proposed.

Structural Design Mainly of Steel

The structural design includes steel columns and roof beams, forming bents spaced 5 ft. c. to c., with a reinforced-concrete floor and concrete jack-arches between the roof beams and wall columns. The report states that experience in New York indicates this design to be generally preferable to a reinforced-concrete design, particularly where the construction is carried on under important business streets. It is more conveniently and quickly erected and is more economical. The design for the low-level subways is similar, but with heavier sections and perhaps with I-beam reinforcement in the floor. A waterproofing membrane of woven fabric laid in pitch or asphalt is provided, but for the low-level subway it may be necessary to use bricks laid in asphalt mastic.

The stations are to be 450 to 500 ft. long (for 10-car trains), with a minimum platform width of 12 ft. Passenger subways will connect the platforms. Electric cables are to be laid in ducts built into concrete benches along the side walls, these benches forming emergency footwalks in case of accident or of trains being stalled. For ventilation, the subway will be divided longitudinally by a curtain wall, so that air will be expelled in front of a train and drawn in behind it. Reconstruction of sewers will be necessary, but will not be a difficult problem.

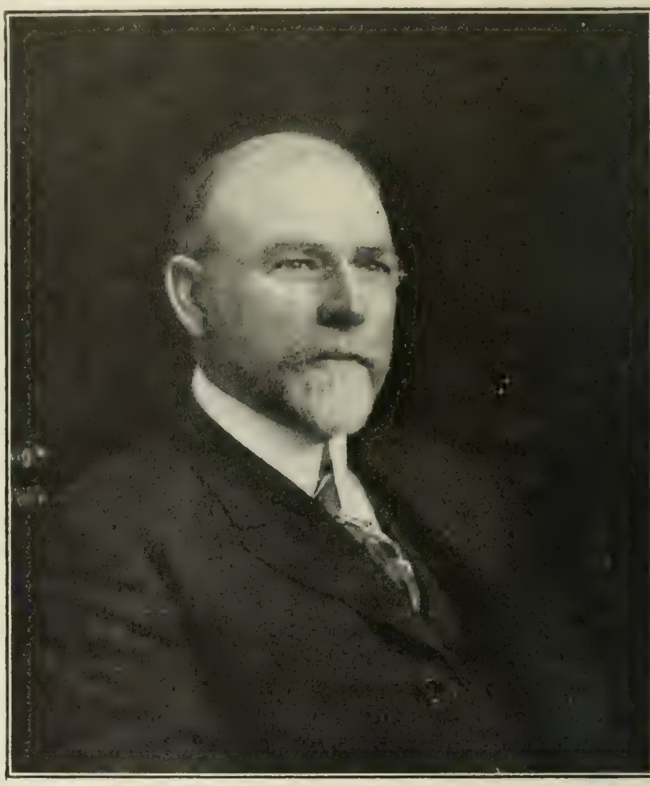
It is proposed also to lay water and gas mains, electric conduits and other subsurface structures in the soil on either side of the subway. A special difficulty occurs at street intersections, where galleries may be required to carry the utilities across or under the subway and where the available space is very shallow. By means of small I-beams placed between the main roof beams the depth of cover may be increased sufficiently for cross-connections of the smaller utilities separated by the subway.

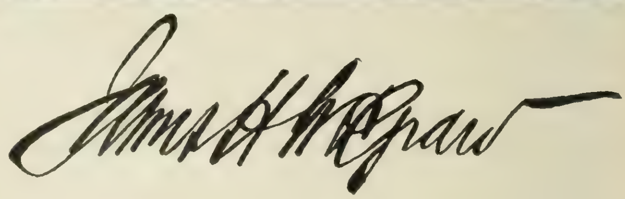
The tracks between stations are to be of ordinary construction, with ties in stone ballast. The stations are to have unballasted tracks, with rails laid on blocks set in recesses in a concrete floor. This will provide for cleaning the floor by flushing or sweeping.

James H. McGraw

For more than a quarter of a century, James H. McGraw, who now becomes the President of the McGraw-Hill Publishing Co., Inc., has been a prominent figure in the field of technical journalism.

In the late '80's, three young men, who had come to New York City from country towns only a short time previous, were associated in publishing three small journals, called *Power*, the *Street Railway Journal*, and the *Journal of Railway Appliances*. The three men were Emerson P. Harris, H. M. Swetland, and James H.





McGraw. Of the three, Harris was the pioneer in establishing the journals and he brought the other two young men from their homes in western New York first as employees, and later (since the business was at that time too impecunious and uncertain to stand much in the way of fixed salaries) as partners. In a short time Mr. Harris sold his interest to the other two men and a separation occurred. Mr. Swetland took the journal *Power*, built it up to a commanding position and sold it in 1902 to the Hill Publishing Co. Mr. McGraw retained the other two journals. His choice was fortunate, for the street railway business was just beginning to be revolutionized by the introduction of electricity. To the engineers who swarmed into the street railway business when the horse car era ended, the *Street Railway Journal* was a necessary aid.

The prosperity of the publication gave its owner the means to extend his enterprise into broader fields. His

acquaintance with the electrical field through street railway work naturally led to his interest in electrical publications. Here there prevailed during the '90's severe competition, and bitter personal rivalries as well. In 1896 Mr. McGraw bought a journal called *Electrical Industries,* which he renamed the *American Electrician;* three years later he purchased the *Electrical World* and the *Electrical Engineer,* and consolidated the three papers as the *Electrical World.*

In 1902 he purchased from Henry C. Meyer the *Engineering Record* and about the same time began the publication of a journal devoted to electro-chemistry, which since 1915 has been issued under the title *Metallurgical and Chemical Engineering* as a semi-monthly. A year ago the widening interest in the electrical field made advisable a division of interests. A journal, *Electrical Merchandising,* was established on the foundation of a small independent journal in that field which was purchased. Quite recently two journals in Chicago devoted to contractors' interests have been purchased and are now issued as *The Contractor.*

In the early days of technical journalism, offices in a down-town office building—and very modest offices at that—sufficed for most journals. With the growth of the business and the establishment of printing facilities, enlarged quarters became necessary. In 1906 an 11-story reinforced-concrete building on West 39th St. was built by Mr. McGraw as a home for his publications; but the lapse of only a few years made necessary an addition as large as the original structure.

Mr. McGraw has always taken an active interest in the industries represented by his journals. He has been especially prominent in the electrical field and is an Associate of the American Institute of Electrical Engineers. He belongs to the Engineers Club, the Railroad Club, the Republican Club and the Aldine Club in New York City. He has resided for many years at Madison, N. J., and is President of the Board of Directors of the Madison Academy.

E. J. Mehren

The choice of Mr. E. J. Mehren, Editor of the *Engineering Record,* for the position of Vice President and General Manager of the newly organized McGraw-Hill Publishing Co., Inc., is a noteworthy promotion of a civil engineer, comparatively young in years, to an executive position of great responsibility.

Mr. Mehren graduated from the civil engineering course of the University of Illinois in 1906, having completed the course in three years of study. His first engineering work was on the locating survey of the Chicago, Milwaukee & St. Paul's extension to Puget Sound; but after a few months an opportunity opened to gratify a desire to undertake work in engineering literature. He came east to New York and began work as an associate editor of the *Engineering Record.*

After four years in this position he was offered and accepted the position of manager of the Emerson Co. of New York (Harrington Emerson, president), efficiency engineers. After little more than a year in this new position he was invited to return to the *Record* as its managing editor and he was made editor-in-chief in August, 1913.

Mr. Mehren's progressive work in his conduct of the *Engineering Record* has made him widely known to the engineering profession. At the close of last year, two important executive officers, Mr. S. T. Henry and Mr. H. M. Wilson, retired from the McGraw Publishing Co., and in January Mr. Mehren was made vice-president of that company. When the recent consolidation of the McGraw Co. and the Hill Co. was effected and the problem arose of finding a man in the two organizations capable of taking the executive responsibility of welding the two organizations into a harmonious working unit, the choice fell upon Mr. Mehren.

Mr. Mehren is intensely interested in the technical side of his profession and especially in the development of

E. J. Mehren

higher standards of conduct and practice and greater achievements in public usefulness by engineers. It surely means much to the entire engineering profession to have an engineer with such ideals and attainments placed in full charge of the greatest engineering publishing house in the world.

Petroleum Production in 1916—Preliminary estimates by John D. Northrop, of the United States Geological Survey, Department of the Interior, indicate that the quantity of crude petroleum produced and marketed in the oil fields of the United States in 1916 was 292,300,000 bbl. This quantity is greater by 4% than the corresponding output in 1915, which reached the record-breaking total of 281,104,104 bbl. Mr. Northrop estimates that 38% of the 1916 total came from the Oklahoma-Kansas field, 30% from California, and the remaining 32% from the Appalachian, Lima-Indiana, Illinois, north Texas, north Louisiana, Gulf coast, and Rocky Mountain fields.

News of the Engineering World

Metropolitan City Planners Confer

An informing and inspiring conference on city and village planning in the Metropolitan District was held in New York on the afternoon and evening of Mar. 10. Strange to say, this was the first conference of the kind held to consider the planning problems that are common to New York City and the adjacent territory. Very appropriately, the conference was held at the City Club, 55 West 44th St., which is rapidly becoming the headquarters for conferences on municipal problems, not only for the Metropolitan District but for the whole country.

The keynote address was delivered to the conference by Nelson P. Lewis, Chief Engineer of the Board of Estimate of New York City, who also acted as Chairman of the afternoon session. The evening session of the conference was presided over by Frank B. Williams, Chairman of the Committee on City Planning of the City Club. A committee on plans for future action was appointed to report to a second conference to be called within two months or so. The members of this committee are Messrs. Lewis and Williams, for New York City; Herbert Angell, Mt. Vernon, N. Y., a member of the Westchester County Planning Commission, for the outlying district to the north; Oscar Maddaus, Mineola, N. Y., Secretary of the Nassau County Association, for the eastern outlying district; and Arthur P. Cozzens, Newark, N. J., Secretary of the Newark City Planning Commission, to represent northern New Jersey.

In his keynote speech, Mr. Lewis spoke of the interrelations of city and town planning in the Metropolitan District. It heretofore has been quite lacking, each city and town not considering the subject beyond its own city limits. Coöperation is eminently desirable. There has been some coöperation in the matters of water-supply and sewage disposal within the Metropolitan District, but practically none in the layout of a comprehensive metropolitan highway system or visible city plan. There is a deplorable lack of highway outlets from New York City to the north.

Various phases of city planning in New York City and its boroughs, and also in the outlying districts in Westchester County to the north, Nassau County to the east, and in the five counties of northeastern New Jersey to the west and north, were outlined by a score or more of speakers. Harry Meixell, Jr., after deploring the fact that in the great highway system established by a recent act of the New Jersey Legislature, the routes have been selected by legislative log rolling instead of in accordance with any scientific planning principles. Mr. Meixell also spoke of the need for broader legislation in New Jersey, illustrating his point by a statement that a bill recently introduced having some relation to city planning related in the first instance to Newark and Jersey City only. Subsequently it was enlarged to include all cities in the state, but there are only some 40 odd of these, whereas the powers granted in the bill are needed by boroughs and towns to a much larger number.

The need of better suburban transit service was forcibly presented by John T. Fox, transport expert to the Committee on City Plan of the Board of Estimate. The completion of the dual subway will vastly improve transit service within the city, but altogether too much time and too many changes of cars are required to get from the city to many suburban points, and particularly to get from say, White Plains, N. Y., to Westfield or to Morristown, N. J. Even a trip from the New York Central to the Delaware, Lackawanna & Western within New York City is exasperating in point of time and inconvenience if reliance is placed on transit facilities. Every railroad out of New York, Mr. Fox went so far as to say, ought to run trains under 20-minute headway. Whether through trains across the city can ever be secured is uncertain, but there at least ought to be better connections and less waiting.

David Grotta of the Newark Planning Commission not only gave an interesting and instructive account of some of the work done by that commission, including conferences with representatives of outlying districts, but showed such fervor and zeal for city planning as means of community and intercommunity benefit as to inspire those attending the conference to greater efforts in behalf of their own community. L. L. Tribus, of the Borough of Richmond, New York City, told of city-planning work, including a very elaborate topographical survey, carried out while he was Chief Engineer of the Borough.

Pennsylvania R.R. Has New Employment System

The Pennsylvania R.R. has put into effect a new scheme of handling applications for employment, intended to encourage applications from more men who live in the vicinity of its lines and shops. Each of the road's 1500 station agents on the lines east of Pittsburgh and Erie becomes virtually an employment agent. There is also an employment clearing house established in the General Manager's department at Philadelphia.

Notices are to be posted conspicuously along the railroad directing all persons desiring employment to see the nearest station agent. The agent is instructed to see each applicant, to learn his capabilities as fully as possible, and to direct him to the nearest shop foreman, supervisor, trainmaster, or road foreman of engines, who are apt to have vacancies in their forces. If there are no vacancies found on the division in which the application is made, the papers are forwarded to the office of the General Manager in Philadelphia.

The General Manager's office, under the clearing house scheme, receives each week from each General Superintendent a list showing the vacancies on his division, covering shop laborers, car repairmen, car cleaners, engine cleaners, brakemen, firemen, freight handlers, trackmen, etc. This results in being able to direct every applicant to the nearest point where opportunity exists.

Railway Officials Formally Dedicate Hell Gate Bridge and Viaduct

The great Hell Gate Bridge and viaduct of the New York Connecting R.R. was dedicated on Mar. 9, 1917, by a party of high officials of the Pennsylvania R.R. and of the New York, New Haven & Hartford R.R., owners of the New York Connecting R.R. A. J. County, Vice-President of the Pennsylvania, opened the brief ceremony. The designer of the structure, Gustav Lindenthal, Chief Engineer of the New York Connecting R.R., responded, turning the structure over to Samuel Rea, President.

Mr. Rea referred to the formation of the company 25 years ago, to the four years of construction work, just completed, and to the great cost of the enterprise—over $27,000,000. He then said the line was transferred to the New Haven for operation as part of its system, to replace the river service for connection between the New England states and the states west and south. E. C. Buckland, Vice-President of the New Haven, accepted for the latter.

The first service over the new line will be the operation of the Federal Express, the long-established through night train between Washington and Boston. This train was transferred by car ferry between Port Morris and Jersey City, across New York Harbor, until Oct. 19, 1912, when it was operated over Poughkeepsie Bridge instead, and the car ferry was discontinued. On Jan. 9, 1916, however, the train was wholly discontinued, except that it was resumed as a weekly train for a short period in the summer of 1916, to enable through travelers to bypass New York during the infantile paralysis epidemic. The train will be restored by the new Hell Gate line about April 1, 1917.

The New York Connecting R.R. is a four-track line about 6 miles long, most of it on steel viaduct and bridge, and the rest on concrete-walled approach. Its main structure is the Hell Gate steel arch, 977½ ft. in span c. to c. skewbacks. There are also important crossings over Little Hell Gate and Bronx Kills.

Ontario Hydro-Electric System Operations in 1916

A statement of the operations of the Ontario Hydro-Electric Power Commission for the year ending Oct. 31, 1916, has been issued by the chairman, Sir Adam Beck. The figures for the Niagara system are: Total average horsepower used 109,583; average cost per horsepower at Niagara Falls, $9.10; total capital cost of system, $9,522,995; interest paid from earnings, $371,404; maintenace costs, $180,962; operating costs, $137,333; cost of power $997,257; total expenses, $1,686,958; total receipts, $2,038,792, leaving a surplus of $351,833. Deducting the sinking fund due on capital cost, amounting to $167,132, a balance of $184,701 is then applicable to the reserve fund.

These figures might warrant a general reduction in rates but this is considered unadvisable in view of the increased cost of a large additional block of power to be supplied this year by the Canadian Niagara Power Co., at $12 per hp. and because of the outlay required for the construction of a duplicate transmission line from Dundas to Toronto.

The Severn district system serving Midland, Collingwood, Barrie, and other towns in that part of the province, showed a net surplus of $26,377 on the year's operations, after paying interest and sinking fund charges. The Port Arthur system had a surplus of $20,862. The Eastern system including the plants taken over from the Seymour interests in the Peterborough district, showed a small operating profit.

Strange Accident on Elephant Butte Dam Causes Two Deaths

An extraordinary accident inside of the large Elephant Butte dam in New Mexico caused the death of two of the power house attendants recently. One of the power house attendants, F. O. Babcock, went on duty and was to be relieved by another attendant an hour or two later. When this attendant went to the power house he could not find Mr. Babcock so went through the gallery inside the dam looking for him. At the air inlet chamber of the west upper valve he found Babcock and H. E. Reid standing with their faces to the wall, dead. Their bodies were apparently held in place by the suction through the air inlet tube. Babcock's right arm was extended into the tube as if he might have been pointing out something to Reid. It is probable that the latter approached closer to see better and his overcoat and the two bodies practically closed the opening, so that the suction due to the vacuum in the tube not only held them both fast to the inlet, but exerted a pressure of some 6000 lb. on that part of their bodies exposed to the action. To release the bodies, the other attendant had first to close the valve. The valves and their layouts were described in *Engineering News,* Nov. 30, 1916, p. 1015.

Blue River Improvement, Kansas City

Preliminary plans for the first steps in a scheme to improve the Blue River within Kansas City, Mo., were approved by the Board of Public Works of that city on Feb. 9. The full scheme, as thus far worked out by Harrington, Howard and Ash, consulting engineers, Kansas City, provides for three low dams to lessen flood conditions and prevent mud-bank exposure at low water; a 140-acre lake; a parked area along the river; boulevards; river canalization and an industrial area, the two last-named below the lower dam.

The Blue River has a drainage area of 275 sq.mi., most of which is outside the city; a maximum flow estimated at 30,000 cu.ft. per sec.; practically no dry-weather flow except the discharge from domestic sewers, which will be diverted by a proposed intercepting sewer, plans for which are being made. The stream enters the city through Swope Park, the largest of the city parks, in the southwest corner of the city, and flows to the Missouri River through alluvial sparsely settled land. The Missouri has a maximum fluctuation in level of 32 ft. and the Blue River of 40 ft., the latter between high muddy banks in Swope Park.

In 1912 the Park Commission, advised by Robert C. Barnet, consulting engineer, recommended a single dam, a lake and boulevards. In 1915 a bond issue of $100,000 to start the improvement was voted, the money to be spent by the Board of Public Works.

The present scheme proposes a dam near 10th St., with a crest at El. 9 (city datum) or 10 ft. above low water; a second dam at 19th St., with crest at El. 21 or 12 ft. above backwater; and a third dam south of the mouth of Brush Creek, with crest at El. 30, or 9 ft. above backwater. The second dam is on the site of the one proposed in 1912. Each dam would be provided with sluice gates, for equalizing water levels and for flushing out silt, which is recognized as a serious problem. Even with the sluice gates closed the stream fluctuation would be reduced to a maximum of 12 ft. and a normal of about 6 ft.

The immediate expenditures recommended are the securing of part of the needed land; building a timber and rock dam at 10th St., with sheetpiling to stop seepage, and a marine railway, at an estimate cost of $40,000 to $45,000; some levee work; and snag removal the whole length of the river. It is also advised that Congress be requested to order an examination of the Blue River from its mouth to the site of the first dam with a view to having this part of the river canalized at Federal expense.

Pollution of the Passaic River by Paterson, N. J., may continue two years more, through an extension of time granted by the court. Riparian owners who had sued Paterson for sewage pollution were awarded damages in 1908, the claims to hold until 1911, when it was then thought that the Passaic Valley trunk sewer would be completed. Extensions have since been made until 1913, 1915 and 1917, and now until 1919.

A System of State Highways in New Jersey, to be constructed during the next five years at a cost of $15,000,000, is practically assured as a result of Senate action on Mar. 8 in passing the Edge tax bill, providing for a tax of one mill on every dollar of assessable property in the state. The bill had been amended in the House to exempt corporations having annual receipts of less than $5000. The bill has gone to the Governor for signature.

Illinois State Departments are reduced from 130 to 9 by a bill that passed the Legislature about Mar. 7. The new departments are: Finance, Agriculture, Labor, Mines and Mining, Public Works, Charities and Corrections, Health, Corporate Control, Education and Civil Service. It is reported that the act "wipes out about 300 jobs and sinecures" and will effect a direct yearly saving of $400,000, besides an unknown saving through greater efficiency.

A Garbage Pier Suit has been brought against New York City by the Hudson Navigation Co., owner of Pier 32, North River, at the foot of Canal St. The company asks for $50,000 damage and an injunction against the use of Pier 33 as a loading place for garbage boats. The complainant alleges that the conditions at the garbage pier are unsanitary and also, if reports be true, that some of its employees have contracted typhoid fever on that account.

An Unusual Kind of Engineering Banquet was given by the Engineering Department of the City of Houston, Tex., on Mar. 2, "in commemoration of the 81st anniversary of the independence of Texas and of the birth of Sam Houston the 124th." The program consisted of the reading of Governor James G. Ferguson's proclamation designating Mar. 2 as "Sam Houston Day," the reading of the Texas Declaration of Independence and a brief sketch of the state's history.

Floods in Southern Rivers reached serious proportions in the past week. At Chattanooga the Tennessee River had reached a stage of 48 ft., which is 16 ft. above official flood stage. Railway communications were interrupted and the street-railway service of the city was practically suspended. North Carolina rivers rose dangerously, and the Catawba—which did such damage in July, 1916—rose 18 ft. and carried out three wooden trestles. Alabama rivers also are at flood stage.

An Activated-Sludge Plant for treating the sewage and industrial wastes from the Chicago packing-house district has been recommended by the committee appointed to consider the question. The cost is estimated at $3,500,000, with an annual operating expense of $800,000. The Sanitary District will pay such share of the cost as will represent the treatment of domestic sewage from the district. The committee was composed of Langdon Pearse, Division Engineer of the Sanitary District of Chicago, and Dr. Richardson, Chemist for the packing-house companies.

The City-Manager Charter for Kansas City, Mo., was defeated Mar. 6 by an actual majority of 70 votes, or since the law required four-sevenths of the total vote cast in order to carry a new charter, it failed of confirmation by over 2300 votes. The foreign quarter and cheap lodging-house section of the city voted overwhelmingly against it, and while it carried in all the residence wards the majorities were not great enough to overcome this lead. Mayor Edwards opposed the proposed charter and promised if it was defeated to immediately appoint a new Board of Freeholders to draft another charter. It is probable therefore that Kansas City will have another charter election this fall.

Lien Rights for Structural Engineers are provided in a bill that has been introduced in the Illinois legislature at the instance of the Structural Engineers' Association of Illinois. There have been many cases where engineers employed in design or construction (particularly on buildings) have been unable to obtain payment for their services. In such cases the only recourse is to bring suit, and many engineers shoulder their loss rather than undertake this proceeding. The bill is identical with the law now in force, except that it gives to structural engineers the same rights as are now given to architects, contractors, material firms and laborers for a lien upon the property for the amount due for services, material or labor. The bill has been read and referred to the Committee on Judiciary.

A Tornado in Indiana sweeping over the central eastern portion of the state on Mar. 11 killed more than 20 people at Newcastle, Wayne County. The number injured may exceed 200, according to press dispatches, and the property damage is estimated at $1,000,000. Most of the buildings were destroyed in a strip 500 ft. wide and 2 miles long. The only steel-frame building in the wind zone was the main building (200 x 60 ft.) of the Indiana Rolling Mills Co. It was of ordinary mill-building construction, with steel trusses, columns, purlins, and brick curtain walls, steel sash and corrugated-iron roofing nailed to wood 8-in. channels. The roofing was ripped off and blown 2 miles, the sash was completely torn out and distorted, and a large portion of the brick walls was torn down. The frame remained practically undamaged. A large brick school building was almost demolished on the leeward side by the sucking action of the wind.

Scioto River Channel Enlargement at Columbus is now expected to be put under contract not later than September. An engineering force is being organized and condemnation appraisers are starting work. This is the outcome of the City Council's adopting the smaller one of two projects reported upon by City Engineer Henry Maetzel, Jan. 15, by instruction of the Council. The two projects were based on an improved channel width of 580 ft. through the central part of the city, but the cheaper project omitted (1) excavation of the berm, (2) improvement work on the Olentangy, which joins the Scioto in the center of the city, (3) channel improvement below Greenlawn Ave., and (4) a large amount of retaining-wall construction near the center of the city. This project was estimated just below $3,500,000, expenditure of which sum for flood protection by channel improvement was authorized by popular vote at the November election. The status of the question at that time was noted in "Engineering News" of Nov. 30, 1916, p. 1055. Following the city engineer's report of Jan. 15, the cheaper project was adopted and the preparation of detail plans was taken in hand.

PERSONALS

S. Camden Miller, whose resignation as Operating Engineer of the Canton Bridge Co. was noted in this column Jan. 4, is now Manager of the Mesker Bros. Iron Co., of St. Louis.

Charles Worthington, M. Am. Soc. C. E., formerly in private practice in New York City, has been made Designing Engineer, Bureau of Yards and Docks, Navy Department, Boston, Mass.

John A. Hoeveler, formerly Assistant Chief Engineer on design and new development work for the National X-Ray Reflector Co., is now Deputy in charge of lighting with the Wisconsin Industrial Commission.

Charles F. Rockwood, formerly Structural Engineer with the Louisville Bridge and Iron Co., is now Principal Assistant Engineer of that concern. He is a graduate of Rensselaer Polytechnic Institute, in the class of 1894.

Charles F. Gray, M. Am. Inst. E. E., consulting electrical engineer, Winnipeg, Manitoba, has been elected Controller for

that city for the ensuing year. Mr. Gray was at one time in charge of the construction staff of the Canadian Westinghouse Co.

G. L. Craig, formerly with John Gill & Sons, general contractors, Cleveland, Ohio, and L. C. Curtiss, formerly with McKim, Mead & White, New York, have organized the Craig-Curtiss Co. for doing a general contracting business in Cleveland.

C. H. McLeod, for more than 29 years Secretary of the Canadian Society of Civil Engineers, has resigned that position and will be succeeded by Fraser S. Keith, Assoc. M. Can. Soc. C. E., whose professional experience is noted elsewhere in this column.

Cyrus Hankins, recently in the mechanical engineering department of the Norfolk & Western R.R., Roanoke, Va., has been appointed mechanical engineer of the James McKay Co., McKees Rocks, Penn. He is a graduate of the Virginia Polytechnic Institute, 1911.

Leander Dorsey, Assoc. M. Am. Soc. C. E., a Rensselaer Polytechnic man, has resigned the superintendency of the Whiting-Turner Construction Co., Baltimore, Md., and is now Manager of the Construction Department of the Cram Engineering Co., of that city.

F. Clark Dugan has resigned his position with the Division of Sewerage of the City of Cincinnati, Ohio, and accepted a position as Assistant Engineer with William G. Clark, consulting engineer, Toledo, Ohio. Mr. Dugan graduated from the University of Kentucky in 1910.

Beverly F. Perry has accepted a position with the Cincinnati (Ohio) Board of Health as First Assistant Sanitary Engineer, to aid W. C. Folsom, Chief Sanitary Inspector, in making the necessary surveys and collecting data for a report on garbage collection and waste disposal for the city.

Gustavus W. Thompson, Assoc. M. Am. Soc. C. E., recently consulting engineer of the Trussed Concrete Steel Co., and Walter D. Binger have combined as Thompson & Binger, Inc., Engineers and Contractors, with offices in New York and Syracuse. Raoul C. Gautier is Chief Engineer of the new company.

H. C. Corns, M. Am. Soc. C. E., formerly Chief Engineer of the Ohio River Contract Co., and C. C. Thomas, formerly Manager of the Wetzel Engineering Co., have incorporated the Corns-Thomas Engineering and Contracting Co., and have opened offices in the First National Bank Building, Huntington, W. Va.

Frank E. Barnes, formerly Chief Engineer of the R. P. Ford Co., Rochester, and a graduate of Rennselaer Polytechnic, '98, is now Building Engineer of the Valuation Department of the New York Central R.R. He left the position of Chief Engineer of the R. P. Ford Co., of Rochester, N. Y., to take his new position.

Arthur W. Robinson, M. Am. Soc. C. E., formerly Sales Manager of the Truck Department of the Locomobile Company of America, has resigned to take the Managing Directorship of Gaston, Williams & Wigmore, Ltd., International Buildings, Kingsway, London, England. He is a graduate of the Rennselaer Polytechnic Institute, in the class of '97.

John H. Leete, Dean of the School of Applied Science, Carnegie Institute of Technology, is to be librarian of the Carnegie Library of Pittsburgh, with the title of Director, in place of H. W. Craver, resigned. Mr. Leete was born in 1868. After serving as Professor of Mathematics at the Pennsylvania State College for several years, he joined the faculty of the Carnegie Institute in 1906, becoming Dean two years later.

Fraser S. Keith, Assoc. M. Can. Soc. C. E. and new Secretary of that society, was born at Smiths Falls, Ont., in 1878. He was graduated in electrical engineering from McGill University in 1903. After a year as senior demonstrator in electrical engineering at McGill, he became Editor and later Manager of "Canadian Machinery," and in 1907 Editor of "Canadian Manufacturer." During the past 18 months he has edited "Construction."

D. F. Coyle, of Winnipeg, Man., has been appointed Industrial Commissioner in charge of the new Department of Resources of the Canadian Northern Ry., with headquarters at Winnipeg. D. B. Hanna, Vice-President of the railway, in making the appointment stated that "in anticipation of the industrial organization and development which will follow the conclusion of peace, and in view of the great number of industrial opportunities on the lines of the Canadian Northern Ry. system, the company has decided to extend its operations in that regard by creating a Department of Resources." Mr. Coyle was secretary to Sir William White from 1896 to 1901, and in the latter year became assistant to R. J. Mackenzie, of Mackenzie & Mann.

OBITUARY

W. H. Elliott, civil engineer, died in Whittier, Calif., on Feb. 28.

Oswaldo Cruz, a noted sanitary engineer of Brazil, died of uremia, on Feb. 11, at Petropolis, Brazil, at the age of 44.

Arthur Brown, architect and engineer, died at his home in Oakland, Calif., on Mar. 7, at the age of 86. Until his retirement 20 years ago he was consulting engineer of the Southern Pacific Ry.

W. H. Baldwin, M. Am. Soc. C. E., for nearly 10 years Deputy City Engineer of Yonkers, N. Y., died in that city on Mar. 6. He was born in Nashua, N. H., in 1859, was graduated from Dartmouth and has worked on municipal engineering projects in Memphis, Buffalo and Norfolk. In 1888 he became Engineer of the Yonkers Water Department, and in 1908, when the city was established, he was made Deputy City Engineer.

Alfred W. Parker, steel inspector for the Boston Transit Commission and a member of the Boston Society of Civil Engineers, died at his home in Waltham, Mass., on Feb. 24, at the age of 72 years. As a young man he and his brothers were associated with the National Bridge Works, a concern that was among the first builders of iron bridges in New England and Canada. He was next associated with Captain Eads at Pittsburgh in connection with Mississippi River improvements. After 10 years with the Boston Bridge Works he began work with the Boston Transit Commission in 1895, and during the past two years was in charge of the structural steel shop.

Peter Siems, a railroad contractor of St. Paul, Minn., and founder of the Siems-Carey Co., died at Daytona, Fla., on Mar. 3, at the age of 75. He was born in Holstein, Germany, and emigrated to the United States in 1865, coming to St. Paul in 1870. After laying out the public highways between Black Hills and Minneapolis, he entered railway-contract work in 1884 with D. C. Shepherd & Co., which later became Shepherd-Siems & Co. In 1908 the company was reorganized under the name of Siems & Co. with Mr. Siems' sons as partners. He retired six years ago and F. W. Carey became identified with the concern. Last October this company concluded a contract to build 1100 miles of railway for the Chinese Government, as noted in "Engineering News," Oct. 5, 1916, p. 673. Mr. Carey is now in China as resident manager of the project.

Col. William Douglas Pickett, of Lexington, Ky., probably the oldest living member of the American Society of Civil Engineers, died at his residence in Lexington, on Jan. 6, aged 89 years. Colonel Pickett, who was descended from an old Virginia family, won his military title by service in the Confederate Army during the Civil War. He served in the Texas Rangers. Some years after the war he emigrated to Wyoming and settled in the northwestern part of the state on the headwaters of the Grey Bull River, where he lived for many years the life of a pioneer and hunter. His exploit of killing four grizzly bears in one day was celebrated by the naming of the post office at Four Bear, as described by Ernest Seton Thompson a dozen years or more ago in his "Story of Wahb." Colonel Pickett returned some years ago to his native State of Kentucky and had resided there since. He became a member of the American Society of Civil Engineers on July 6, 1863, and was made an honorary member of the society in 1914. His only surviving relative is a brother, 92 years of age.

ENGINEERING SOCIETIES

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 20. Annual meeting in Chicago at Coliseum. Secy., C. W. Kelly, Kelly-Derby Co., Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 21-22. Annual meeting in Chicago. Secy., Horace H. Clark, 1325 Edison Building, Chicago.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 20-22. Annual meeting. Congress Hotel, Chicago. Secy., E. H. Fritch, 900 South Michigan Ave., Chicago.

ST. LOUIS RAILWAY CLUB.
Apr. 13. Secy., B. W. Frauenthal, Union Station, St. Louis.

DETROIT ENGINEERING SOCIETY.
Apr. 21. Secy., D. V. Williamson, 46 Grand River Ave., W., Detroit.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
Apr. 26-28. In Dallas. Secy., H. S. Cooper, 405 Slaughter Building, Dallas, Tex.

The American Iron and Steel Institute will hold its 12th general meeting May 25 and 26 in New York City, at the Waldorf-Astoria Hotel.

The Engineers' Club of Philadelphia will hold its annual meeting on Tuesday, May 15, at the Engineers' Club. The secretary is R. H. Fernald, 1317 Spruce St.

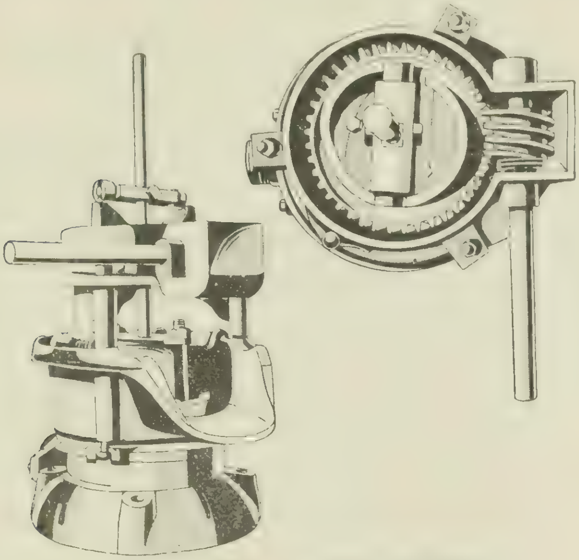
The American Chemical Society will hold its annual meeting Apr. 10 and 11, in Kansas City, at the Hotel Muehlebach. The secretary is Charles L. Parsons, Washington, D. C.

Idaho Society of Engineers—The officers elected at the annual meeting are as follows: President, Will H. Gibson, Mountain Home; vice presidents, W. O. Cotton, Idaho Falls, and G. C. Schart, Boise; secretary, Ira F. Shaffner, Boise, Idaho.

Appliances and Materials

Worm-Drive Power Diaphragm Pump

A new type of power drive for diaphragm pumps has been placed on the market. The drive comprises a worm gear and cam lift in a frame interposed between the pump rod and the source of power, which may be a gasoline or steam engine or an electric motor. The engine turns a horizontal shaft carrying the worm gear. The worm drives a circular gear and rotates a ball-cam lift whose follower carries the pump rod. By means of this cam the reversing of the stroke can



WORM-DRIVEN DIAPHRAGM PUMP

be accomplished without shock or vibration, so that the pump is claimed to need no ballast or anchorage.

The driving mechanism is made to be readily attached to any stock diaphragm pump without alteration; it is said that the change can be made in a half-hour. The power may be applied either by belt or direct connection. The price of this attachment is $100, and that of the pump complete on a platform with a 2½-hp. gasoline engine is $175. The pump and drive alone is sold for $125. The device is made and the patents are owned by the Clinton Power Pump Co., Clinton, Mass., of which Oren B. Bates is selling agent.

* * *

Rustproofing Process for Steel

A chemical process for the rustproofing of all sorts of steel and iron articles has been developed by Clark W. Parker, of Detroit, and is being promoted by the Parker Rust-Proof Co., of that city. The rights for the use of the process are licensed to large manufacturing firms, and many automobile concerns have adopted it. Small plants can have the work done in various branches of the parent company.

The process gives a dull etched appearance to the surface, but it is claimed that neither the size nor the contour is altered. The coating is elastic; treated springs are used in the ordinary way, and parts can be drawn down without losing the rustproofing. The protection is specifically limited to atmospheric attack and not to such service as in contact with wet ashes, brine or forced blasts of warm moist air.

The rustproofing bath contains phosphate salts and is heated to the boiling point; the cleaned articles (sand blasted or pickled) are immersed and the temperature held for two hours. There is at first vigorous effervescence with the evolution of hydrogen; this action gradually slows up, owing to the deposition of a black insoluble basic iron phosphate. The articles are finally removed, air dried and dipped in oil; they may be painted or enameled.

* * *

Plane-Table Alidade with Elbow Eyepiece

W. & L. E. Gurley, Troy, N. Y., has recently placed on the market a light-weight alidade, with a 10x2¾-in. blade and an 8-in. telescope with elbow eyepiece, which is called an "explorer's" alidade. It is a companion instrument to the same company's "Explorer" transit and "Explorer" level. All three instruments may be carried in a 24-in. suitcase. The chief feature of the new alidade, aside from its light weight

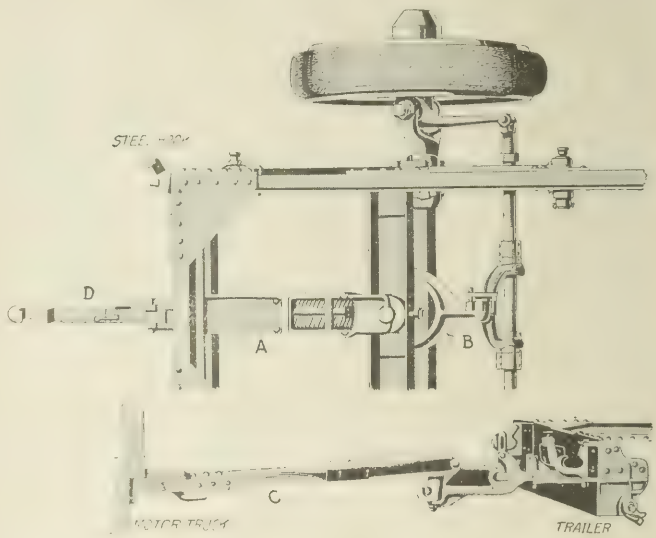
PLANE-TABLE ALIDADE WITH ELBOW EYEPIECE

and small size, is the elbow eyepiece. This is designed to relieve the fatigue and inconvenience experienced in observing with the ordinary plane-table alidade. The new eyepiece also increases the range of the instrument, making possible readings with the telescope depressed 25° or elevated to 30°. The price varies from $90 to $120, according to equipment.

* * *

Trailer-Truck Steering Gear

A new design of trailer truck for motor haulage has been made by the Warner Manufacturing Co., of Beloit, Wis., having a special coupling and steering gear to insure that the trailer will track with the tractor and neither whip out nor cut in. The tractor also can back the trailer into position. In the accompanying view, A is the drawbar, with two sets of springs to take up shock in pulling and pushing respectively. At B is a yoke hinged to the end of the drawbar (beyond the pivot) and connected by a ball-and-socket joint with the tie-



WARNER TRAILER-TRUCK DRAFT GEAR

rod yoke. In coupling truck and trailer, a coupling bar is hooked on to the truck and laid on the drawbar nose, as shown. The truck is then backed until the pin in the end of the coupling bar drops into the self-locking pocket D. Hooks for the attachment of the connecting bar are provided also at each corner of the frame, for use in operating the trailer in difficult short turns, as in placing the trailer at cars in railway yards. These trailers are made in five sizes weighing from 1 to 2 tons and having capacities of 1½ to 7 tons.

Engineering News

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Pleasing Architectural Appearance of the Central Bridge at Lawrence

By E. K. Cortright*

Special efforts have been made in the design and construction of the Central bridge, Lawrence, Mass., to secure a pleasing æsthetic appearance. This reinforced-concrete highway structure, 80 ft. wide and approximately 1700 ft. long, crossing the Merrimack River, furnishes access directly to the center of the business district. The roadway, paved with granite blocks, is 56 ft. wide between curbs, with provision for double-track street-railway traffic.

The approaches at either end consist of earth-filled retaining walls of the counterfort type and 44-ft. span segmental arches directly supporting the floor slab. The seven river spans are 116 ft. center to center of piers, with a rise of 20½ ft. Each of these spans has three arch ribs supporting bench walls that provide bearing for the floor system of transverse beams and floor slab. As the approach work presents a broad plain-surface appearance, it brings into pleasing contrast the light open-spandrel treatment of the main arches. Massive shore abutment piers, hollow above the ground, serve to accentuate the river spans. At the bridge floor provision has been made for future construction of pylons to emphasize this effect further.

In the original design the six river piers, 9 ft. wide at the springing line, were to be built on compact river gravel 14 ft. below normal water. Legislation subsequent to the award of the contract necessitated provision for possible future navigation. Consequently only four river piers were completed as designed, the two middle piers being redesigned to act as abutments for a future bascule span. Permission was obtained from the Federal authorities to construct a concrete span over the proposed channel, with the understanding that the city will remove the concrete span and provide an operating bascule draw upon demand of the War Department. Compressed-air caissons were used in sinking these bascule abutment piers to bedrock, 25 to 50 ft. below the river bed.

The striking treatment of the massive bascule piers above the springing line deserves attention, as its use in this country has been very limited. A battered face truncates what otherwise would be the triangular prism at the pier nosing, the shape of the imaginary piece removed being that of an inverted triangular pyramid. The resulting effect is to lighten greatly the appearance of these piers and to remove what otherwise would be a decided tendency for them to appear bulky and topheavy.

THE NEW CENTRAL BRIDGE, LAWRENCE, MASS., A STRUCTURE DESIGNED FOR PLEASING APPEARANCE

The intrados of the main arches is three-centered for the sake of economy, but approximates an ellipse for its pleasing appearance. These arch rings were poured in a series of blocks and keys; to overcome the unsightly appearance of the joints, all voussoir faces are divided by means of scoring strips into a series of voussoir blocks. These blocks vary proportionately in depth and width from the crown to the haunches.

The balustrade was designed with special attention to aid the appearance of lightness of the bridge in side elevation. The predominance of vertical lines in the balustrade secures this effect. An uneven number of panels was used to avoid the heavy appearance occasioned by a post directly over the key of the arch. The balustrade concrete was mixed in 1 : 2 : 3 proportions with granite dust and chips for aggregate. All panels are bushhammered with a pleasing result.

The Central bridge was built for the City of Lawrence by Ryan & Keon, of Boston. B. H. Davis is Consulting Engineer.

*Resident Engineer, Central Bridge, Lawrence, Mass.

Sinking Extensive Caisson Foundations for a St. Louis Hotel

Concrete piers built in wells or caissons sunk by the pneumatic process form the foundations for the new Statler Hotel at St. Louis, Mo., and rapid progress was a feature of this foundation work. The building is to be 150 x 130 ft., with the longer front on 9th St. and the shorter sides on Washington Ave. and St. Charles St. It will be 18 stories high, with basement and sub-basement. The architects are George B. Post & Sons, of New York, and Mauran, Russell & Crowell, of St. Louis. The contract for the foundation work was taken jointly by the Fruin-Colnon Contracting Co., of St. Louis, and the Missouri Valley Bridge & Iron Co., of Leavenworth, Kansas.

The foundations consist of 50 concrete piers, 5 ft. 6 in. to 8 ft. 3 in. in diameter, sunk through water-bearing sand to bedrock (white limestone) at a depth of about 55 ft. below the sidewalk level (or 27 ft. below the floor of the open excavation). Fig. 1 shows the work in progress in this excavation, at about the sub-basement level.

The caissons are built of vertical planks $2\frac{3}{4} \times 5\frac{1}{2}$ in., in 14-ft. lengths, with inside and outside girts or ring braces of angles $3 \times 3 \times \frac{1}{4}$ in. The cutting edge is a $\frac{1}{4}$-in. plate 24 in. high, with a plate $6 \times \frac{3}{8}$ in. and angle $3 \times 3 \times \frac{1}{4}$ in. riveted inside the bottom. At the plane of the top of this angle is a course of interior bracing consisting of two sets of steel plates $4 \times \frac{1}{4}$ in., put together like the segments of arch or tunnel centering. This construction is shown in Fig. 2.

The 5 ft. working chamber above the cutting edge was of concrete, with a wall 6 in. thick. Above this was the steel shaft, 3 ft. 6 in. in diameter, supporting the air lock at the top. The shaft was in 8-ft. lengths, each composed of four vertical segments having interior angles, with wooden key strips $2\frac{1}{4} \times 4$ in. bolted between them. By removing the bolts and timbers the shaft sections could be collapsed and removed. As the working chamber sank, the outside of the wall was sheathed and the steel shaft extended, while concrete was filled into the annular space between this shaft and the sheeting.

A pressure of 10 to 15 lb. was carried in sinking the caissons, which necessitated weighting them with pig iron, as shown in Fig. 1. Excavated material was taken out and concrete taken in by means of buckets of 9-cu.ft. capacity. When rock was reached, holes were drilled to a depth of 6 ft. to insure that the work was in solid rock, after which the working chamber was filled with concrete. The steel shaft was collapsed by removing the bolted wood keys (Fig. 2), and the space within the concrete shaft lining was then filled to the top with concrete.

FIG. 1. SINKING CAISSONS FOR FOUNDATION PIERS FOR THE STATLER HOTEL AT ST. LOUIS, MO.
Note the pig-iron loading on some of the caissons. Also the height of concrete retaining wall. At the left is the cable incline for wagons and in the foreground are some of the cutting-edge sections for caissons

As the site has three street fronts, the only adjacent buildings are at the rear; and here a party wall of the seven-story Lindell Building has to be carried. The site was excavated to a depth of about 28 ft. below the sidewalk level by means of revolving steam shovels. The material was loaded into horse-drawn dump wagons, the teams being assisted up the steep driveway to the street by means of a steam hoist with cable hitched to a dummy or car pusher (Fig. 1). The compressor plant comprised a steam-driven Ingersoll air compressor of

900-cu.ft. capacity and a belted Sullivan compressor of 1000-cu.ft. capacity, the two machines being worked alternately. The caissons were served by three stiff-leg derricks with 50-ft. booms.

Cantilever girders were required to carry the columns at many points. Most of the outer piers have enlarged

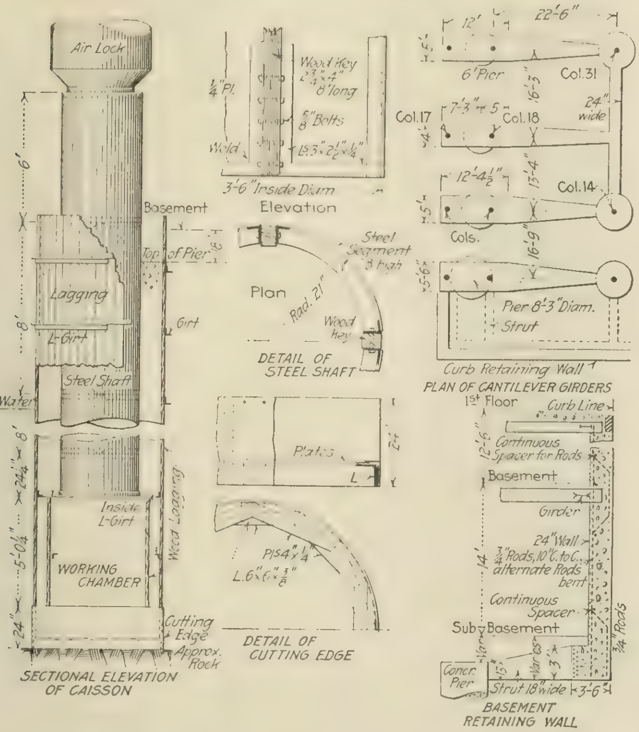


FIG. 2. SHAFT FOR FOUNDATION PIERS AND CANTILEVER FOOTINGS

cantilever caps serving as footings for two columns, spaced sometimes at equal and sometimes at unequal distances from the center line of the pier (Fig. 2). As piers could not be sunk under the party wall, the wall columns here are seated on the ends of reinforced-concrete cantilever girders, each carried by a pair of the concrete piers.

A 24-in. reinforced-concrete retaining wall extends around three sides of the lot, at the curb line, and owing to its height this had to be braced during construction. Its bottom is braced against the heads of the foundation piers by concrete struts (Fig. 2), while as soon as the steel structural work was commenced, the top of the wall was braced against the steel columns by struts and girders carrying the basement floor and first floor.

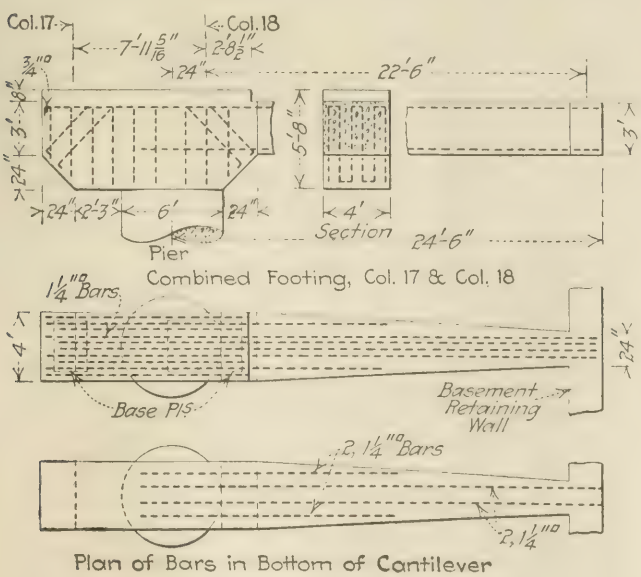


FIG. 3. DETAILS OF CANTILEVER GIRDERS TO CARRY PARTY-WALL COLUMNS

Rapidity of progress was one of the essentials of the contract. About six caissons were under way at a time, and the entire number (50) were sunk and concreted in about 50 days. The work included 17,000 cu.yd. of excavation (including old rock foundations that required blasting) and 1600 yd. of concrete in walls and piers. All this was completed in 110 calendar days and nights, which was 10 days ahead of contract time, in spite of 35 days of excessively hot weather.

Knocking Down 120-Ton Electric Locomotives for Export

Three 120-ton electric locomotives had to be shipped from the Erie Works of the General Electric Co. to the Bethlehem-Chile Iron Mines Co., at Tofo, Chile, but the lifting capacities of ship and dock cranes for loading on board vessels, and for removing on arrival, were insufficient. It was therefore necessary to take the locomotives apart, to classify the parts according to size and weight, and to box them into easily handled shipping cases.

The locomotives were erected at the Erie Works, put on test tracks and run under operating conditions to bring out defects of material or workmanship. These machines follow the lines of a half-unit of the Chicago, Milwaukee & St. Paul type, are intended for use on 2400-volt direct-current circuits, and have regenerative braking equipment.

After test, the parts were all marked and ticketed in systematic order, so that the locomotive could be reassembled exactly as it stood under test. First, the pantograph trolleys were taken off and then the hatch covers of the roof, exposing the control and regenerative braking equipment. Through the openings thus made, the smaller parts were taken off—including the motor-generator set, air compressor and the control-equipment supports and contactors.

While these parts were being boxed, the roof, weighing 5 tons, was removed. (Roof and sides had been assembled with bolts and nuts to facilitate dismantling.) The roof was packed on the locomotive platform after the equipment had been stripped from it. All the electrical connections were opened up after the removal of the roof, and the various panels, contactor compartments and other apparatus were removed. Then the sides and end frames were taken down.

The platform proper was the heaviest part of the shipment, weighing 16½ tons; with the roof and necessary boxing for shipment, this package weighed 23 tons, being the heaviest single article.

The motors were removed from the trucks, the brake rigging and accessories were disassembled, the trucks were separated, and the axles were removed. When thus completely prepared for rail shipment, one locomotive occupied three box-cars and five flat-cars. With the exception of the one 23-ton case, the entire shipment was stowed in the hold of a South American freighter (the "Celia," owned by W. R. Grace & Co.). The big case was lashed on deck.

Art Gallery Built on a 200-Ft. Bridge

The new extension of the Chicago Art Institute presents the unusual feature of a building that is structurally a two-span bridge, as it spans the depressed tracks of the Illinois Central R.R. and is carried by through trusses concealed within the side walls of the building. One end of the new structure connects with the main building on Michigan Ave., and the other end has its entrance in Grant Park. It is a two-story building about 230 ft. long and 58 ft. wide. The width of the railway right-of-way is 200 ft. between the retaining walls. The arrangement and general structural design are shown in Fig. 1.

The main structural part of the building consists of two steel through-truss spans 101 ft. 3½ in. long, supported on end walls and a central pier. These trusses are 27 ft. 3 in. c. to c. of chords and are spaced laterally 53 ft. 7 in. c. to c. Upon their top chords are seated the transverse roof trusses. The building was intended originally to have but one floor, with a clear height of about 30 ft., this to be used as a statuary room. Its floor was designed for a live-load of 300 lb. per sq.ft. Later, it was decided to use it as a picture gallery, with two floors, allowing a load of 100 lb. per sq.ft. on each floor.

The truss design is peculiar in that the end panels at the center pier are half the length of the other panels; that is, each truss has five panels of 18 ft. 5 in. and one end panel of 9 ft. 2½ in. The bottom chords, however, are spliced at their abutting ends. One set of gusset plates serves for the connections of the two steeply inclined end posts and serves also to splice the chords. Thi. is shown in the detail drawing, Fig. 2.

The bottom chord is a heavy box girder 48 in. deep, having two webs 15 in. apart, with vertical diaphragms between them. Each web has from two to four plates, with outside flange angles from end to end and inside flange angles in the middle panels. Top cover plates are fitted between the posts, and lacing bars connect the bottom flanges.

The end posts and top chords are of generally similar design, but with 24-in. webs and with top and bottom lacing and batten plates. The two adjacent top chords are connected at the hips by a light longitudinal member that forms part of the auxiliary framing to carry the interior walls, etc. The posts are of H-section. They are riveted between large connection plates and extend through and above the top chords, as attachments for the roof trusses. The diagonal members are pairs of rolled or built-up channels, with top and bottom lacing.

In the first floor the floor-beams are pairs of 30-in. plate girders spaced 24 in. c. to c. The end floor-beams, however, are single 60-in. girders. Between these are framed the stringers, which are mainly 15-in. I-beams spaced 5 ft. 9 in. c. to c. On this steel framing is a 4½-in. reinforced-concrete slab deck and a 3-in. concrete floor. The stringers and girders are incased in concrete. A 3-in. shield of asbestos blocks will be placed beneath the level of the floor-beams, being carried by hangers attached to the steel frame.

The second floor has transverse 24-in. plate girders and 24-in. I-beams framed between the truss posts. The depth of truss did not permit second-story floor-beams of sufficient size for the 53-ft. span, and as columns in the first floor were not permissible, it was decided to carry the middle of each floor-beam by a hanger from the roof truss above it, as noted later. The stringers are 24-in. I-beams with 10-in. hollow-tile flat-arch floor construction covered with a concrete floor. Beneath this is a ceiling of metal lath and plaster, carried by hangers attached to the floor framing.

The roof was designed originally with light trusses, simply strong enough to carry the roof framing and glass covering. When it was decided to carry part of the second-floor load from the roof, it was necessary to reinforce these trusses materially. This was done by means of reinforcing trusses, as shown in Fig. 3. Each consists of inclined chords beneath those of the original truss, with their ends connected by a horizontal chord. Each of these members consists of a pair of 15-in. channels connected by batten plates, the original trusses being sandwiched between the channels. The hangers are flat bars attached to connection plates at both chords and carrying gussets to which the floor-beams are riveted.

The outer ends of the main trusses are carried by H-section columns embedded in the concrete retaining walls on the right-of-way lines. The columns of each pair are connected near the top by a plate-girder strut seated on brackets, but there are no bottom struts or diagonals to connect the columns and form a bent. The inner ends of the trusses are seated upon the columns of a steel bent embedded in a concrete pier between the tracks. The columns are of H-section and very similar to those

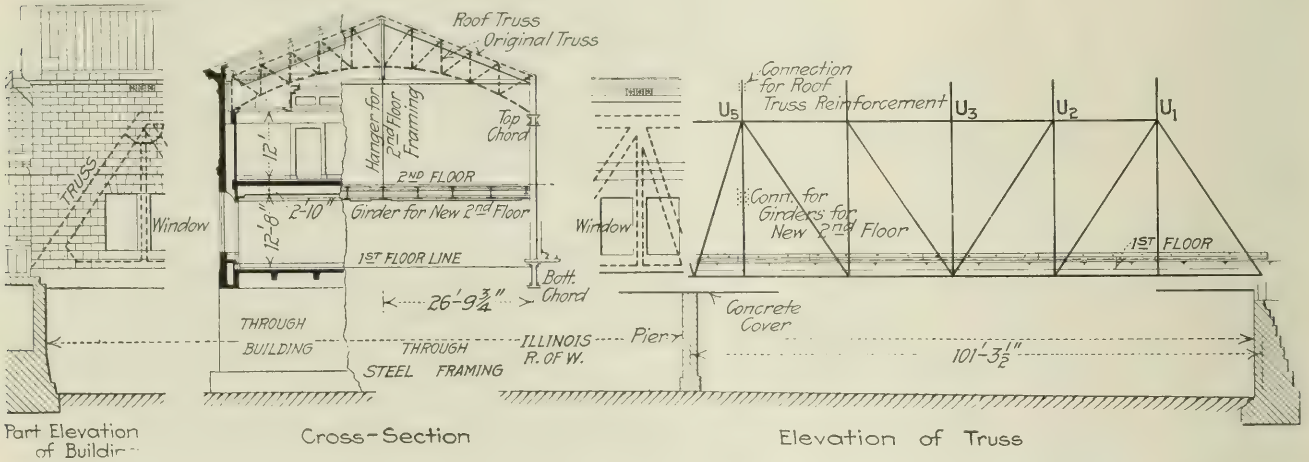


FIG. 1. EXTENSION OF THE CHICAGO ART INSTITUTE SPANNING RAILWAY RIGHT-OF-WAY 200 FT. WIDE

at the outer ends. They are 20 ft. 3 in. long, 20¼x29⅜ in. in section and are of very heavy construction. Each side web is composed of three 20-in. plates and two outside flange angles, with an 8-in. outside plate between the edges of the angles. The transverse web is composed

from the roof, which is covered entirely with glass. The lower floor has windows, but they are not made to open. An outside gangway is provided for the use of the cleaners.

A curious feature of the erection work was that the

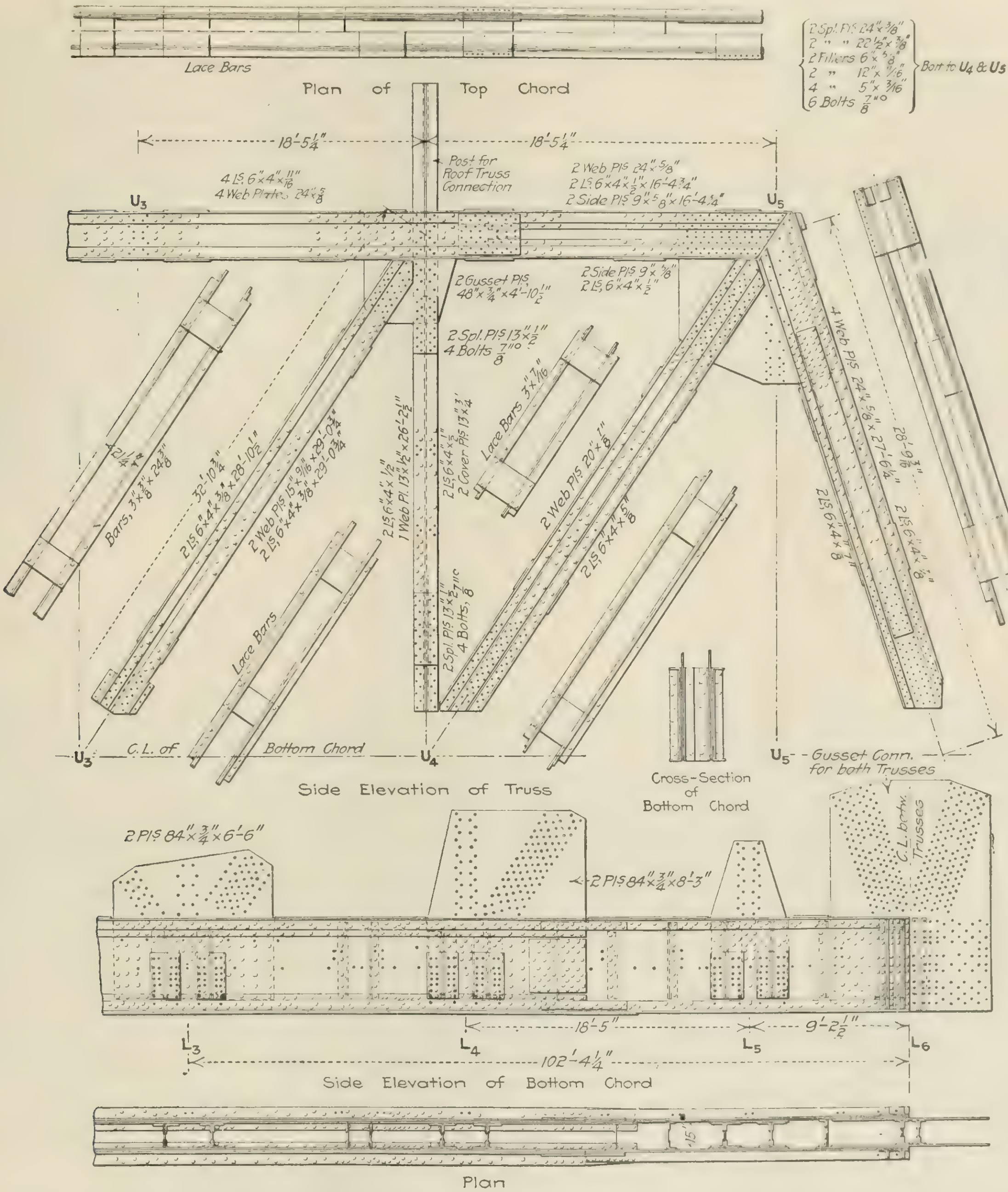


FIG. 2. DETAILS OF 100-FT. MAIN TRUSS CARRYING ART GALLERY FOR CHICAGO ART INSTITUTE

of a single 12-in. plate with four connection angles, and the side webs are connected by batten plates. These columns are connected by top and bottom struts and a pair of diagonals.

The original intention was to have all the steelwork embedded in concrete. As constructed, however, only the bottom chords and first-floor framing are so covered. The truss members and upper-floor framing are incased in tile fireproofing. The roof trusses, on the other hand, are left exposed.

The exterior walls are of stone veneer, anchored to steel girts between the truss members. The inner walls are of tile The upper floor has no windows, but is lighted

bottom chords of the trusses remained in place for two or three years (as simple beams of 100-ft. length) before the truss members were placed. The chords had been made heavy enough to stand in this way, in order to avoid the necessity of falsework between tracks during the erection.

The architects are Coolidge & Hodgden. The truss design was made originally by the Illinois Central R.R. engineers, but the revised form of the structural design was made for the architects by Julius Floto, consulting engineer.

The steel was fabricated by the American Bridge Co. and erected by the Oscar Daniels Co.

Deep Foundations of Metropolis Bridge; Built Under 51 Lb. of Air

By W. McCready*

The construction of the Paducah & Illinois R.R. Co.'s bridge over the Ohio River at Metropolis, Ill., offers a number of novel and interesting features, among these being the extensive use of silicon and nickel steel in the superstructure, the construction of the longest simple-truss span in the world and the unusually large and deep foundations.

The Ohio River at this point is about 3000 ft. in width at low water and 7000 ft. at extreme high water, the gage showing a variation of 53 ft. between low- and high-water stages. The underlying soil consists of yellow and blue clay, gumbo and sand, rock being found only at a depth of 240 ft. below low water. It was therefore decided to use spread foundations and land the piers on a stratum of fine white quartz sand that, the soundings showed, lay at a depth of 70 to 90 ft. below low water. (See the strata found in sinking, Fig. 8.)

The total length of the bridge is 5700 ft. The north approach is 1593 ft. long, of deck plate-girder and tower construction with slab-ballasted deck, on pedestal foundations, with the exception of three piers, *A*, *B* and *C*. The river portion, seven truss spans, consists of a 300-ft. span at the north end, four 551-ft. spans, one 720-ft. span and one 246-ft. deck span. The south approach includes 605 ft. of viaduct construction of the same type as the north approach and an 85-ft. fill containing about 1,000,000 cu.yd. of earthwork.

All steel was designed for Cooper's E90 engine loading, with two engines on the near track followed by a train load of 7500 lb. per lin.ft., and on the far track the train load only. In the truss spans all main members except eye-bars are of silicon steel, with an allowable unit-stress of 30,000 lb. per sq.in. All eye-bars and pins are of nickel steel, with allowable tensile unit-stress 35,000 lb. per sq.in. and bearing of 20,000 lb. per sq. in. All other material is medium steel at 20,000 lb. tension and 24,000 lb. tension and compression for wind stress. The total weight of steel in the truss spans and approaches is 17,000 tons.

The construction of the seven river piers was done by contract, and the remainder of the substructure work by company forces.

The pedestals are of round-shaft type, 5 ft. in diameter at the top, side batter ½ in. to the foot, on a 19½-ft. octagonal foundation 3 ft. deep containing four-way reinforcement of ¾-in. corrugated bars at 6-in. centers

*Principal Assistant Engineer, Paducah & Illinois R.R., Metropolis, Ill.

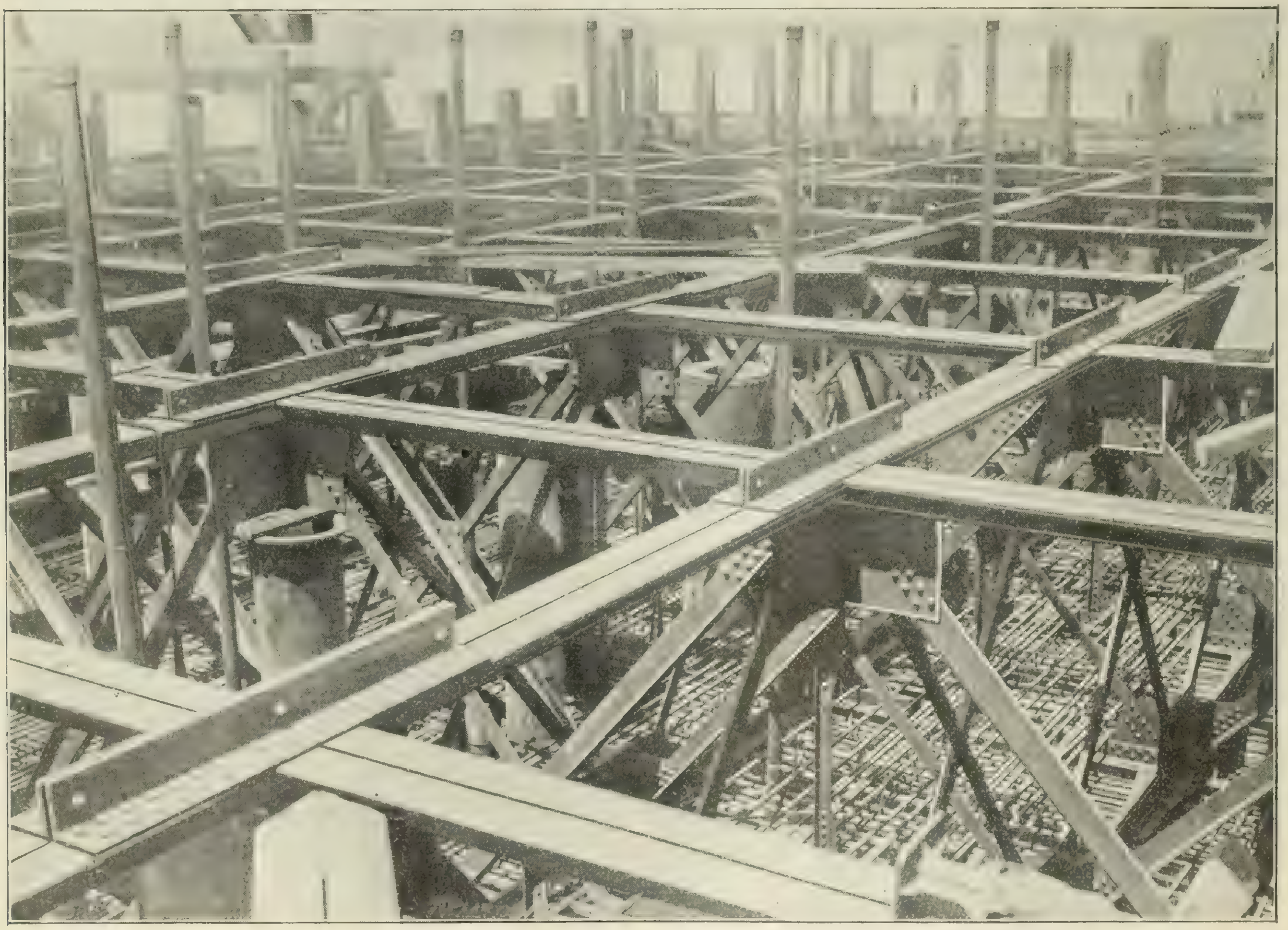


FIG. 1. STEEL TRUSSES AND BOTTOM REINFORCEMENT IN THE ROOF OF THE WORKING CHAMBER

Trusses carry the concrete until it has set sufficiently to take load. This keeps load off timber roof of working chamber

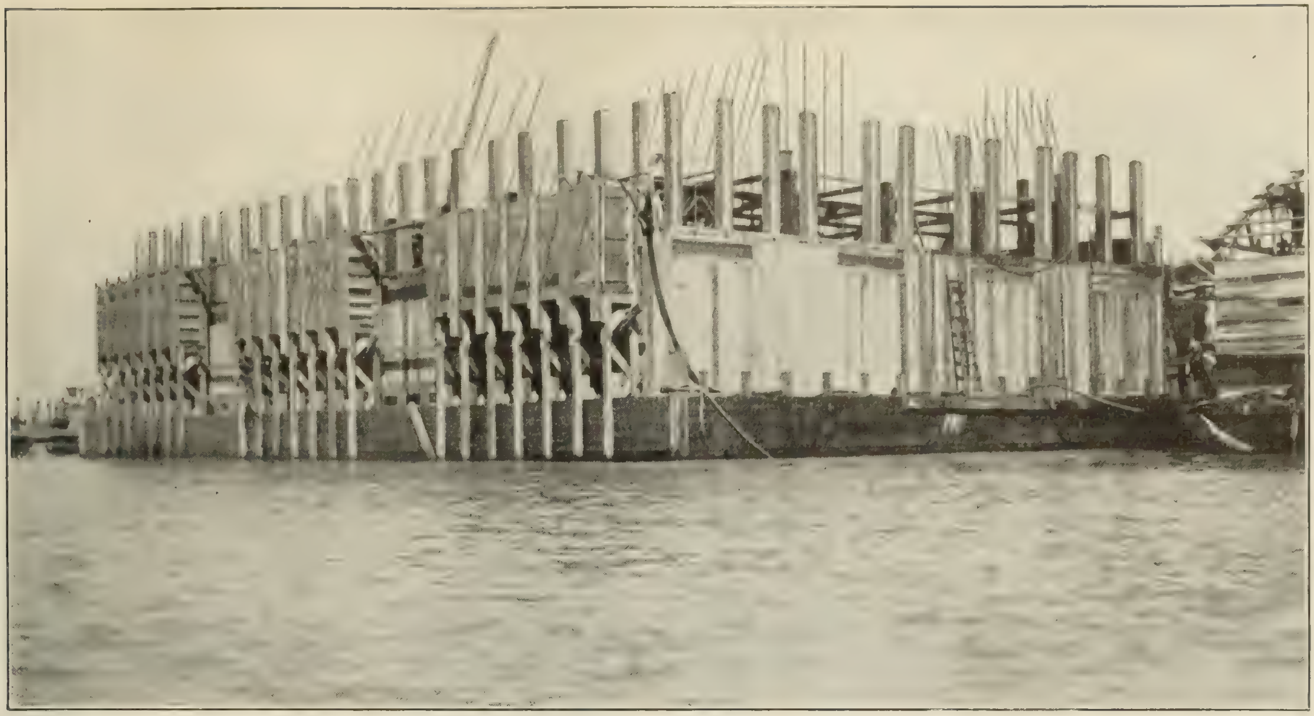


FIG. 2. CAISSON 6 IN THE PONTOON, ABOUT TO BE LAUNCHED

in the bottom. The shafts are reinforced with ¾-in. vertical and ½-in. hoop bars, and the seats with a grid of ¾-in. bars 3 in. on centers.

A construction track was built on the center line of the bridge between the pedestals, and the excavation done with a Browning locomotive crane, using bucket and skip. Practically no sheeting and bracing was required, even in pits 22 ft. deep, as the material gone through was a very stiff clay. A ⅓-cu.yd. motor-driven mixer mounted on a flat-car, using 2200-volt current from the city power lines, was used on the north approach, and a steam-driven mixer of the same size on the south approach. The motor-driven mixer also poured the 13,400 lin.ft. of concrete piling required and the 445 deck slabs, all made in a special yard near the bridge site.

The pedestal forms, of special design, were furnished by the Blaw Steel Construction Co.

Pedestals 1 to 20 inclusive and piers *A*, *B* and *C* were put down to a very hard cemented gravel. For pedestals 21 to 33 inclusive, 20-ft. concrete piles 14x14-in. section were driven to gravel, using a water jet. Each pedestal contains 22 of these piles. A test pile driven into this gravel required 56,255 blows with a No. 2 Vulcan steam pile hammer to secure a penetration of 15 ft. No sinkage showed under the last 2600 blows.

The Deep River Piers

Work was started in June, 1914, but owing to war conditions was suspended in September, 1914, and resumed in June, 1915. As the river was then at a low stage, the caisson for pier 1 was built on the ground. Air was turned on, July 27, 1915, and sinking proceeded with no delays, averaging 1.2 ft. per day until landed on a very fine white sand, Sept. 22, 1915, and sealed five days later. The pressure plant for this pier, consisting of three units supplying a maximum of 3600 cu.ft. of free air per minute, was established on shore, about 200 ft. from the pier site.

In sealing, the working chamber was divided into four compartments by bulkheading from the truss timbers to the roof. In this way a section could be poured before setting commenced, the end sections being run first. Concreting was done with the concrete lock on the material shafts. A special barge of fine gravel was used to secure a free-running mixture.

Bearing tests taken with hydraulic jack on the sand in all piers showed a value of over 20 tons per sq.ft. The area of the bearing block was 139.4 sq.in., using as large a block as possible to develop the full capacity of

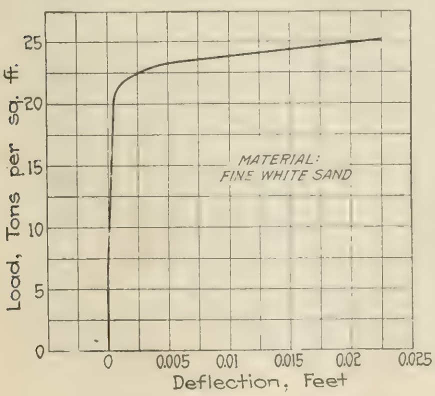


FIG. 3. CURVE FROM SOIL-BEARING TEST AT PIER 1

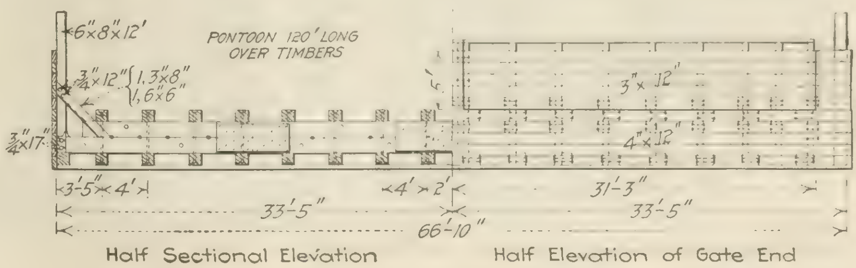


FIG. 4. CROSS-SECTION OF PONTOON FOR FRAMING AND LAUNCHING THE PIER CAISSONS

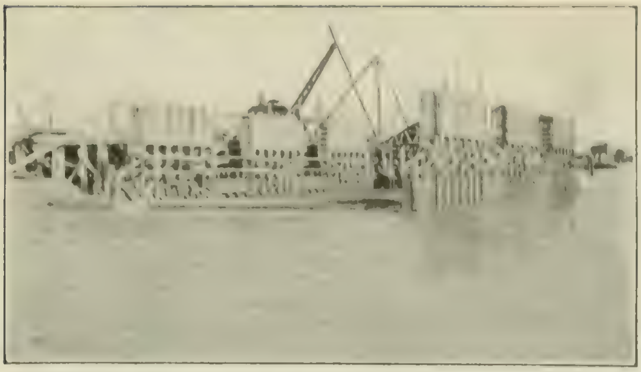


FIG. 5. GATE END OF THE LAUNCHING PONTOON

the jack. Fig. 3 shows a typical curve plotted from one of these tests.

Caisson 7, the next built, was also constructed on shore in position, but a brush and sand mat about 7 ft. thick on the stream side was required, as the bank sloped about 45° at this point. The caisson was built 21 in. off center to allow for drifting. The correctness of this allowance was proved when, in spite of the fact that the caisson was kept over 3 ft. out of level, it came to true position after being sunk 16 ft. No trouble was experienced in holding this position during the remainder of the sinking. The sinking averaged 1.41 ft. per day.

Caisson 6, the next built, was the largest of the seven, being 60½x110½ ft. Caissons 2, 3, 4, 5 and 6 were built in a pontoon 65x120 ft. (Figs. 4 and 5) and floated to position.

An interesting feature of this pontoon was the use of a gate for submerging instead of the usual split design. One end was so constructed that it would float out when the pontoon had obtained a submersion of about 6 ft. Attached water boxes, containing about 75 tons when filled, were used to sink the pontoon clear of the caisson, when it was easily floated out. Fig. 4 shows the pontoon framing.

Considerable delay was experienced at pier 6, due to high water. It was finally landed Mar. 21, 1916, and sealed Mar. 24, 1916.

High Water Made Greatest Depth of Work 113 Ft.

Piers 2 and 3 were started Dec. 8 and 11, 1915, respectively, and a great deal of difficulty was encountered. High water caused about two months' delay, and there was trouble with scour at No. 3. During the crest of the high water, soundings showed a scour of 16 ft. at the upstream end of the caisson, with a penetration of about 17 ft. Sand bags jetted under the cutting edge and dumped from the surrounding dock finally checked the action.

Caisson 2 was sealed at a depth of 111.5 ft. below water, Apr. 25, 1916. Caissons 4 and 5 followed; and on account of the scour at No. 3 and because clay showed in the bottom, they were sunk about 12 ft. farther than originally intended. No. 4 was sealed at a depth of 113.2

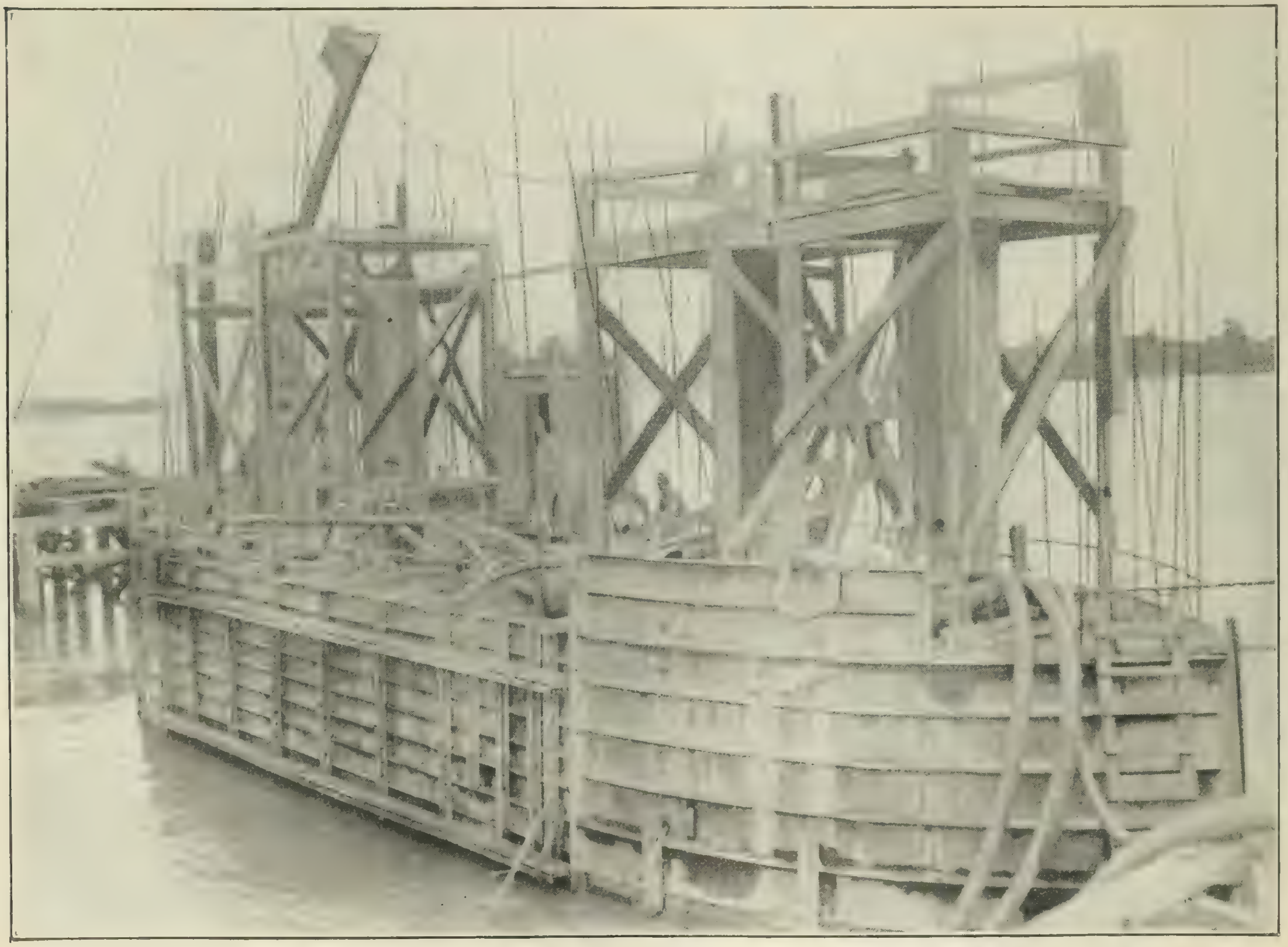


FIG. 6. THE DEEPEST PNEUMATIC WORK: 51-LB. PRESSURE. VIEW TAKEN WHEN SEALING PIER 4, AT DEPTH 113.2 FT.

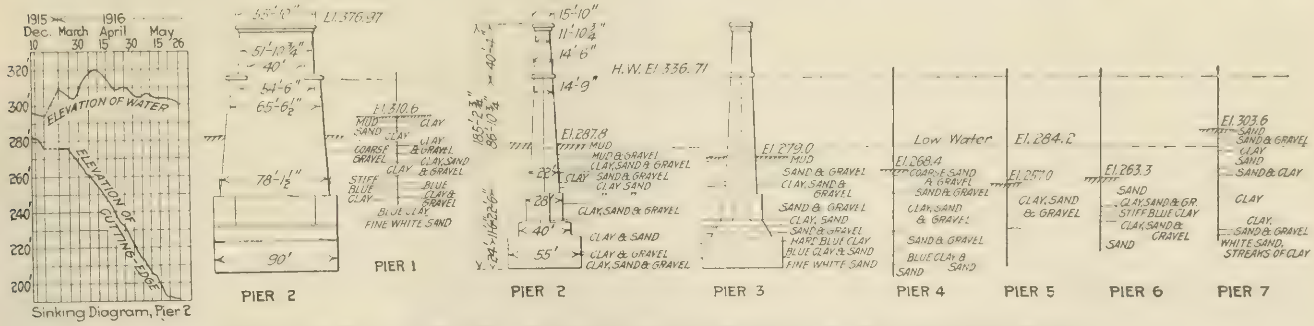
ft. below water, with air pressure of 51 lb. No trouble was experienced, the men working $\frac{3}{4}$-hr. shifts with no bad effects.

Caisson 5 showed the best progress of any of the piers, the sinking averaging 2.15 ft. per day through sand and clay. Throughout the job the sinking on all caissons averaged 1.5 ft. per day, or 300 cu.yd. of material excavated.

Two pressure plants on barges were maintained for Caissons 2 to 7, each containing units supplying a maximum of 3500 cu.ft. of air per minute, an electric-light plant for the working chamber and outside light, condensers, pump and hospital lock. A telephone line was also connected with an instrument in the working chamber.

All air lines were run in coils through running water, and the main shafts were protected with corrugated sheets, making a water space. In spite of this, some high temperatures were recorded in the air locks—125° at No. 1—due to the great air pressure and the frequent concreting.

Accurate records of sinking were kept up to date as the work progressed. The location of caissons was checked every morning by triangulation from one of the base lines, and a copy of the report was given at once to the sinking foreman. Fig. 7 shows a combination of the two progress charts for pier 2, made for the permanent record.



FIGS. 7 AND 8. THE SOIL STRATA ENCOUNTERED AT THE VARIOUS PIERS

At left, sinking diagram of pier 2. Cutting edge laid Oct. 10, 1915; total days sinking, 167; delays, 100; actual days sinking, 67; average sinking per day, 1.37 ft.; maximum per day, 3.42 ft.; maximum immersion, 111.5 ft.; maximum pressure, 50 lb. Pier finished July 14, 1916

All concrete was poured with a $1\frac{1}{4}$-cu.yd. Ransome steam-driven mixer, mounted on a barge with 70-ft. tower and derrick for transferring gravel from barges to feeder bin. Cement was handled from barges loaded from cars at the material dock. The gravel was bar run, furnished by the Union Sand and Material Co., of Memphis, Tenn., and pumped about 13 mi. above the bridge. Five 300-cu.yd. barges and one of 135 cu.yd. were required to keep the mixer going.

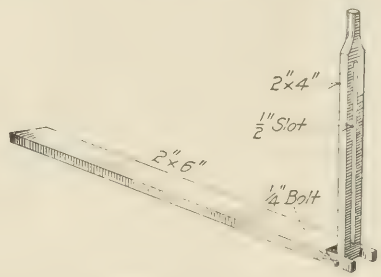


FIG. 10. SKETCH OF TAPE-PULLER

The piers were completed with a derrick boat equipped with a 100-ft. boom seated on a second deck about 22 ft. above the water, giving a total working height of about 115 ft. Concrete was handled in 1-cu.yd. buckets. Steel pier forms furnished by the Blaw Steel Construction Co. were used.

The total excavation on the job was 116,800 cu.yd., of which 103,000 cu.yd. was air work. The total concrete was 93,400 cu.yd., in which 129,000 bbl. of cement and 2,100,000 lb. corrugated bars were used.

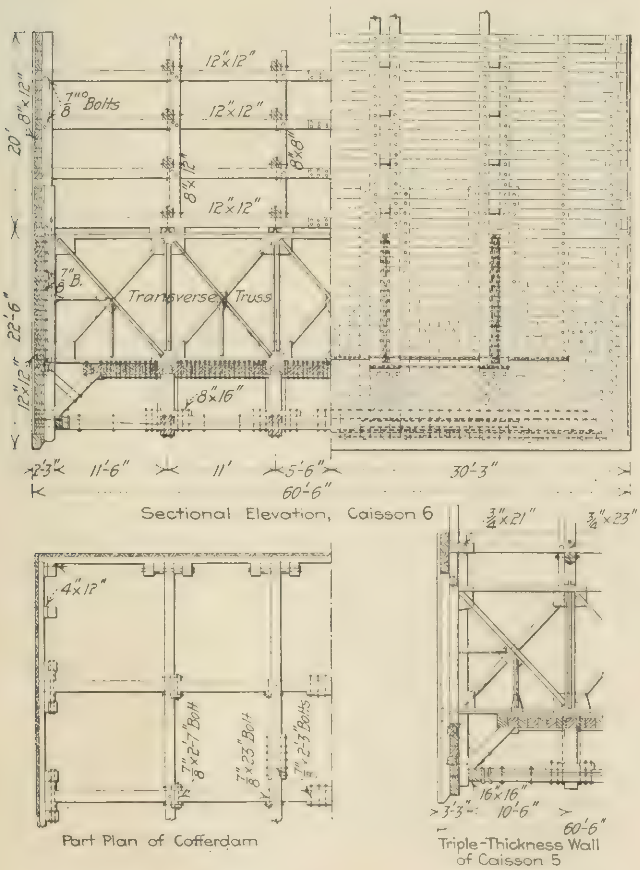


FIG. 9. CAISSON OF PIER 6, AND SECTION SHOWING TRIPLE WALL FRAMING IN CAISSONS

Some Points in Design of the Piers and Caissons

In the design of piers a maximum toe pressure of 6.5 tons per sq.ft. was allowed, with the following items taken into consideration: Total dead- and live-loads; impact; load of soil on the footing projections; a horizontal load for the fixed end of a span equal to 20% of the total live-load on one track applied at top of rail, and a load of 1% for the expansion end; wind load at 45° over an area of 20 ft. above top of tie, considered as a closed area, and above that $1\frac{1}{2}$ times the area of one truss, and the total area of end bracing for one end; ice, 3 ft.

thick at high water plus current at 10 mi. per hour. Deduction was made for buoyancy, but skin friction was not considered.

Caissons 1 and 2 were of similar type, using a horizontal outside course of 12x12-in. timber and a vertical inside course. The friction plank were vertical, and a wood truss supported the deck. Caissons 3, 4, 6 and 7 were of similar design, but steel trusses (Fig. 1) were used in place of wood on account of the much greater size of those piers (Fig. 9).

Caisson 5, however, was designed with three instead of two courses of 12x12-in. timbers, a vertical outside course, a horizontal middle and a vertical inside course, as also shown in Fig. 9. The friction plank were placed at 45°. Steel trusses were used as in Nos. 3, 4, 6 and 7.

The necessary spread of foundation was secured by three offsets or steps from the shaft width, averaging as follows for the seven piers: First step 6 ft. wide, 23 ft. high; second 12 ft. wide, 11 ft. high; third 15 ft. wide, which carried out to the full width of the caisson and 24 ft. above the cutting edge. In addition to the saving in concrete and decrease in weight, a considerable saving in cofferdam material was effected, as the construction allowed the greater part of it to be cut loose and floated out for use on the remainder of the piers.

An Open Dredging Pier

Pier 8 was sunk by open dredging, using a concrete caisson 38x63 ft., with 8 pockets separated by 2-ft. walls. Two stiff-leg derricks were used to bucket the material. The caisson was sunk 50 ft., and, the foundation not being as good as the soundings had indicated, wood piles at 3-ft. centers were driven in each pocket, using a set of roller leads working on top of the caisson.

Sealing was done with a tremie made of 10-in. pipe and handled with the derricks. A 9-ft. course of concrete was placed under 40 ft. of water. When pumped out, practically no leaks developed.

Steel erection started on the north approach Oct. 27, 1915. To date the north and south approaches, the 246-ft. deck span and the 720-ft. span have been erected. The erecting of the 720-ft. span was described in *Engineering News*, Dec. 21, 1916.

Two base lines were used in locating the piers, one on the Illinois shore and one on the Kentucky shore, each about 2000 ft. in length. A good location could not be secured for either of these, because there was considerable difference in elevation between the ends and too much angle between the base lines and the bridge center line (Illinois side, 78°; Kentucky side, 87°).

Measurements were taken with a Government-tested 100-ft. tape and thermometer, using pulling and holding standards as shown in Fig. 10. The tape was supported at ends and center; marking was done on zinc strips tacked to the top of 2x4-in. stakes. A small turnbuckle was used on the rear end of the tape to adjust the zero to the stake marking. All measurements were taken at night or rainy days, and corrections were made for temperature, sag and pull. The probable error in the Illinois base line was 1 in 1,500,000, and in the Kentucky line 1 in 2,000,000.

All angles were read 12 times, 6 direct and 6 reversed, using a Buff & Buff precise transit with 8-in. horizontal circle reading to 10″ of arc and equipped with a striding level. The maximum error of closure in any triangle was 3″. No check measurements on center line of bridge have been possible as yet.

The Paducah & Illinois R.R. was incorporated by the Chicago, Burlington & Quincy R.R. and the Nashville, Chattanooga & St. Louis Ry. to build the bridge and about 15 mi. of line from Metropolis, Ill., to Paducah, Ky. The road is now in operation, using a car ferry over the Ohio River.

The late C. H. Cartlidge, Bridge Engineer of the Chicago, Burlington & Quincy R.R., was Chief Engineer of the Paducah & Illinois R.R. and designed the bridge. C. R. Fickes was Resident Engineer in charge of construction and is now Chief Engineer.

The Union Bridge and Construction Co., of Kansas City, Mo., had the contract for the seven river piers, and the American Bridge Co. the contract for fabrication and erection of the superstructure.

Cantilever Highway Bridge Over the Mississippi

SYNOPSIS—New bridge for highway and electric railway traffic at Burlington, Iowa, built at such an elevation as not to require a draw span. Financed in an unusual way, and will become the property of the city.

The new highway bridge across the Mississippi River at Burlington, Iowa, is expected to be completed this spring. It is designed to carry interurban cars, but at first will be used only as a highway bridge, and will be a link in the "Burlington Way" automobile route. It is the first highway bridge at this point, and is located at High St. about a mile above the bridge of the Chicago, Burlington & Quincy R.R. The nearest crossings are at Muscatine, Iowa, about 60 mi. upstream, and at Fort Madison, Iowa (on the bridge of the Atchison, Topeka & Santa Fe Ry.), about 20 mi. downstream. The general design is shown in Fig. 1.

The new bridge was designed by the Wisconsin Bridge and Iron Co., of Milwaukee, Wis., and is being built by that firm. The preliminary surveys and design were under the supervision of J. F. Jackson and C. W. Brooks, of the company. The substructure work was in charge of C. F. Womelsdorf, as Resident Engineer, and F. A. Ross was in charge of the superstructure as Superintendent of Erection. The bridge is being built for the Citizens Bridge Co., which was organized by members of the Commercial Club of Burlington.

The financing of this project is unique, in that the city is helping to pay for the structure by means of a special tax levy, and under an arrangement whereby the bridge will eventually become the property of the city. The cost is approximately $200,000. The city is furnishing $95,000 by means of tax levy; $80,000 will be obtained by sale of bonds, and $25,000 from sale of common stock to members of the Commercial Club. The Citizens Bridge Co. will issue preferred stock to the

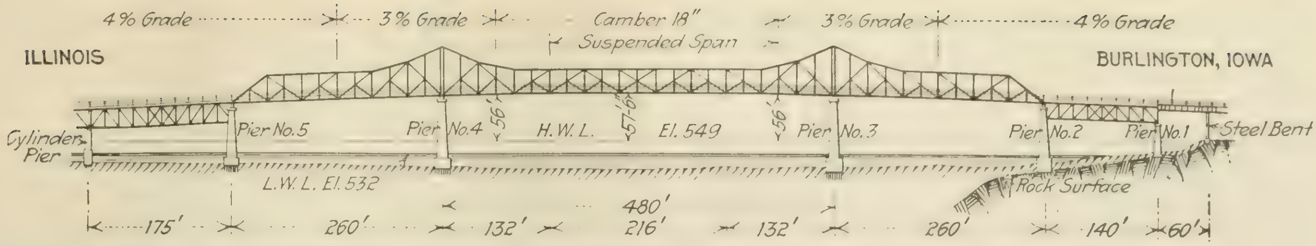


FIG. 1. MAIN CANTILEVER SPANS OF NEW HIGHWAY BRIDGE OVER THE MISSISSIPPI RIVER AT BURLINGTON, IOWA

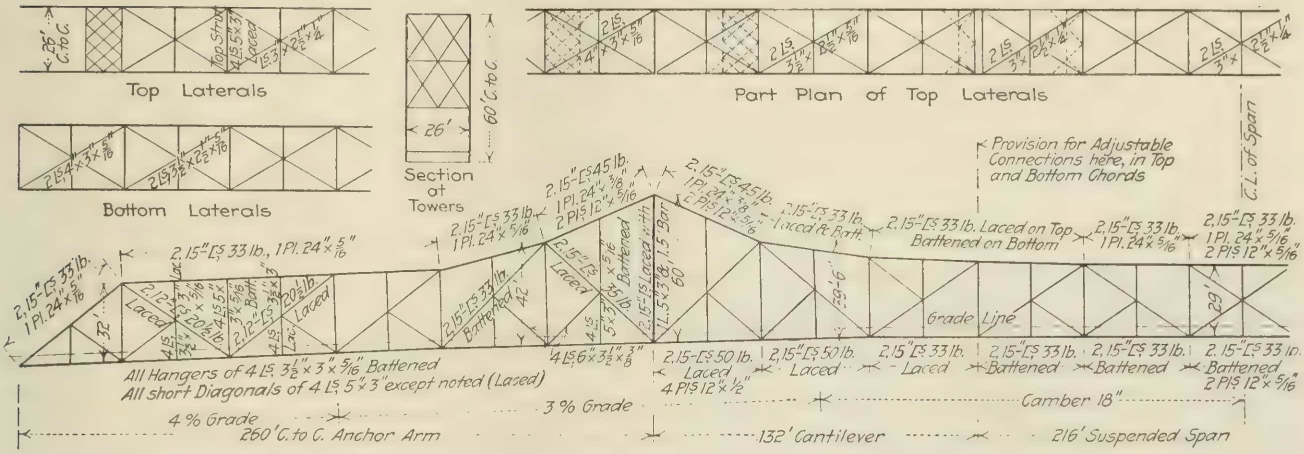


FIG. 2. TRUSSES OF THE CANTILEVER BRIDGE AT BURLINGTON, IOWA

city dollar for dollar for taxes collected, and will also give the city a perpetual option on the common stock at par plus 6% interest. By availing itself of this option, the city will own all the stock, and the bridge becomes the property of the city subject only to the bonds outstanding.

The total length of the structure is 2555 ft., and of the steelwork 2463 ft. The main portion consists of a cantilever channel span 480 ft. c. to c. of piers, and two anchor-arm spans 260 ft. long. The channel span is composed of two cantilever arms 132 ft. long, carrying a 216-ft. suspended span. With grades of 4% and 3% a clearance of 56 to 57½ ft. above high water is obtained for a width of about 280 ft. in the channel. This meets the government requirements for navigation and avoids the cost and operating expense of a draw span.

The Burlington (west) approach begins at High St. with 90 ft. of fill between retaining walls, followed by eight girder spans of 30 to 66 ft., and a deck truss span of 140 ft. The outer end of this span is carried by the pier which supports the anchor arm of the cantilever span. The Illinois (east) approach begins at a county levee with a short fill, followed by six girder spans of 50 ft. and 76 ft. 3 in. and four deck truss spans of 120 to 175 ft. The approaches have grades of 4% to the ends of the anchor arms and 3% grades extend thence to the suspended span.

The foundations and masonry work were completed early in December. At that time the superstructure of the Burlington (west) approach had been erected, and also the anchor arm of the main span, while the west cantilever arm had been commenced. On the east side, the girder spans of the approach had been erected. In January the work was done on the ice, piles for falsework being driven, and one 120-ft. east approach span was erected in four days.

The suspended span will be erected from each end as extensions of the cantilever arms, being tied back temporarily to the towers over the piers. For this purpose the top chord is designed to be a rigid continuous member in erection. When the span is completed the chord will be cut and adjustable connections made between the cantilever arms and the suspended span.

Substructure Features

The foundations of the west approach and the first two main piers are on rock, which is near the surface. Beyond the second pier the rock falls away by a steep

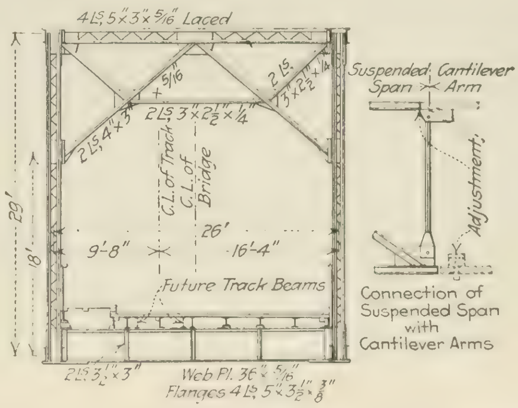


FIG. 3. CROSS-SECTION AND DETAIL OF BRIDGE
Arrangement of points for adjustment at connections of the suspended span with the cantilever arms

slope and all the remaining foundations are on piles driven in the gravel bed of the river and the soft soil of the Illinois side. The substructure consists of four main piers for the cantilever spans and an additional pier for the west flanking span. The girder spans of the west (Burlington) approach have steel bents. All piers for the east approach are pairs of steel cylinders placed over foundation piles and filled with concrete. The main piers have timber piles which were cut off at 8 ft. below low-water and extend about 5 ft. into the hardpan stratum below the sand of the river bed.

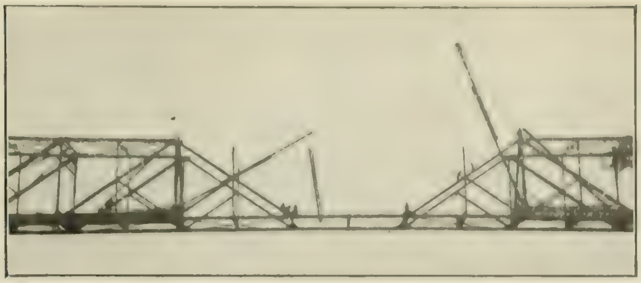


FIG. 4. COMPLETING THE SUSPENDED SPAN

Above the high-water line each pier consists of a pair of concrete pedestals, panelled on three sides, and connected by a 12-in. curtain wall or diaphragm. The pedestals and walls are reinforced with steel rods and angles. The main piers carrying the ends of the deck-truss flanking spans have the central portion (between the pedestals) made much thicker up to the level of the seats for these spans. Pier No. 1 is only 13 ft. high in all and has its two pedestals connected only by diaphragms at top and bottom.

The cylinder piers on the east side were used on account of soft foundation, as they give a relatively light load. Each pier has a pair of cylinders (4 to 5 ft. diameter in different piers) built of 5/16-in. plates, and in most cases these are telescoped into cylinders of 3/8-in. plate 5 ft. 9 in. to 7 ft. 3 in. diameter, and 13 to 19 ft. high, with their tops 7 ft. above low-water line. These lower cylinders surround the heads of the 35-ft. foundation piles.

The cylinders are filled with concrete, the filling of the lower and upper sections being bonded together by means of vertical reinforcing rods. Plate-girder struts are riveted between the lower (enlarged) portions of the cylinders of each pier, while the upper portions are connected by girders or angle struts with angle diagonals, according to the height of the pier. The largest piers have 60 to 85 yd. of concrete, while the others have from 22 to 55 yd. The load per pier (including steel, concrete and reaction from weight of spans) is from 80 to 178 tons.

The steel bents for the Burlington (west) approach have posts of 12-in. Bethlehem girder I-beams, battered 1:12, and connected by struts and diagonals. The retaining walls of the filled part of this approach are 12-in. thick, with 30-in. footings, and have 4-in. pilasters (24 in. wide) on the outside, spaced 13 ft. 4 in. c. to c. Drainage is provided by inclined weep-holes of 2-in. pipe. The thrust on the walls is taken up by transverse 1¼-in. tie rods in the panels and pilasters. These are 30 in. below the coping and have nuts and square bearing plates on the outside.

The details of the cantilever span and suspended span are shown in Fig. 2. The trusses are spaced 26 ft. c. to c. and have a depth of 29 ft. in the suspended span, 32 ft. in the parallel chord portions of the arms, and 60 ft. over the piers. The bridge carries a 20-ft. roadway and 4-ft. sidewalk as shown by the cross-section, Fig. 3. There are nine lines of 10- and 12-in. I-beam and channel joists. When a car-track is laid, this will be placed next to the sidewalk. The floor has a lower course of 3½-in. creosoted plank, laid with 6-in. spaces and spiked to wood strips bolted to the webs of the joists. This is covered with a wearing surface of 2-in. oak plank. The sidewalk has a single course of 3-in. plank.

The cantilever trusses are riveted throughout, except that pin connections are provided for the connections with the suspended span. The chords are pairs of 15-in. channels, laced or battened in different panels and in some panels having 24-in. cover plates and 12-in. side reinforcing plates. The main posts (on the piers) are pairs of 15-in. "girder" I-beams, spaced 3 ft. c. to c. (longitudinally) and laced with 3x3-in. angles. The truss posts and other web members are composed mainly of four angles or two channels, with lacing or batten plates. Plate-girder floor beams are framed between the lower ends of the truss posts, and transverse struts between the upper ends. The top and bottom lateral bracing has diagonals in two-panel lengths. The usual sway bracing is provided, and also portal bracing on the inclined ends of the cantilever arms and suspended span.

FIG. 5. THE BURLINGTON CANTILEVER BRIDGE. COMPLETED IN FEBRUARY, 1917

In the deck-truss spans, the trusses have top chords of two channels and a cover plate (two angles in the end panels) and bottom chords of four angles with a cover plate or battens on the under side. The posts and diagonals are composed of two or four angles. These trusses have a dead load of 1450 to 1550 lb. per lin. ft. of span.

The bridge is designed for a live-load on the roadway of 2000 lb. per lin.ft., or a 15-ton road roller or 40-ton trolley car with 30-ton trailer, these concentrated loads being placed on the various spans so as to produce the maximum stresses in the floor system. For the sidewalk, the live-load is 100 lb. per sq.ft. The wind load is taken at 20 lb. per sq.ft. on exposed surfaces. The dead-load (exclusive of floor) is about 2200 lb. per lin.ft. for the cantilever arms and 1850 lb. for the suspended span. The weight of steel will be about 800 tons for the three cantilever spans, or a total of 1700 tons for the bridge.

John S. Dennis, President Canadian Society of Civil Engineers

By A. S. Dawson*

John Stoughton Dennis, the newly elected president of the Canadian Society of Civil Engineers, was born on Oct. 22, 1856, at Toronto. He is the son of Lieut.-Col. J. S. Dennis, the first surveyor general of Canada and subsequently deputy minister of the Department of the Interior.

Mr. Dennis was educated at the Toronto and Kingston grammar schools and at Upper Canada College. He subsequently graduated from the old military school at Kingston, Ont., before the creation of the Royal Military College. When only 16 years of age, he joined a Dominion Government survey party in the Province of Manitoba—then the very Far West; and he played the game so well that two years later he was attached to an extensive trigonometrical survey, establishing longitudes. He served his articles as a Dominion land surveyor with the late Lindsay Russell, assistant surveyor general, and was commissioned as a Dominion topographical surveyor in 1877.

In 1878, he was given charge of a special survey running base-lines between meridians. In 1879 he entered the service of the Hudson's Bay Co., at which time Donald A. Smith, afterward Lord Strathcona, was the head. The land department of that company was organized by Mr. Dennis, and during the following two years he did much exploration work on the Plains and on the eastern slope of the Rocky Mountains.

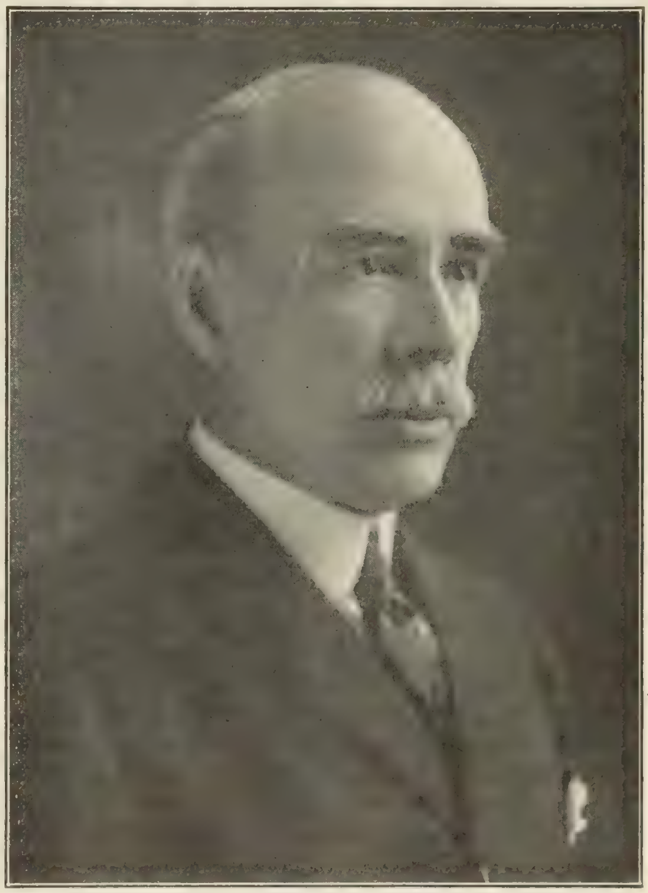
During the Reil Rebellion in 1885, he commanded, with the rank of captain, an intelligence corps of scouts attached to General Middleton's column and made up of surveyors and pioneers thoroughly familiar with the country. He retired with the brevet rank of major in the Canadian militia and with mention for special services at the battle of Batoche.

During the period between 1882 and 1884, he was senior partner of the firm of Dennis, Vaughan & Co., in private practice as surveyors and engineers in Winnipeg. In 1885 he reëntered the service of the Dominion Government. Promotion dogged his footsteps, and in 1892 he became general inspector of surveys in western Canada. In 1896, he joined the service of the Northwest Territorial government as chief engineer and became deputy commissioner of public works in 1897. During this period he was commissioned to visit the irrigated districts of the United States with a view to obtaining first-hand information in connection with irrigation, which it was evident would play an important part in the development of certain sections of western Canada. As a result of this work he took charge of the irrigation surveys and framed the "Irrigation Act," which, with certain amendments, is still in effect. Several large projects proved to be feasible, and most of them have been constructed—the largest being those tributary to the Bow River, east of Calgary, constructed by the Canadian Pacific Railway Co., and serving about three-quarters of a million acres.

In 1902, Mr. Dennis affiliated with the Canadian Pacific Ry., as superintendent of irrigation and chief engineer of the company's large irrigation projects in Alberta. Subsequently he became land commissioner and then assistant to the second vice president, in general charge of all that company's land and irrigation interests in western Canada. In 1912, he was promoted to assistant to the president of the Canadian Pacific, with headquarters at Calgary, Alta., and placed at the head of the Department of Natural Resources, embracing all the company's land, timber and mining interests in the West. In 1916, he was transferred to Montreal as assistant to the president of the Canadian Pacific Ry., and at the head of the newly created Department of Colonization and Development.

During the past 13 years he has had general direction of the building of some of the largest irrigation works in existence, including the noteworthy reinforced-concrete structures known as the Bassano dam and the Brooks aqueduct.

Mr. Dennis has always taken a very keen interest in military matters. As already noted, after the Reil Rebellion he was transferred to the Reserve of Officers with the brevet rank of major; and in 1916 he was gazetted lieutenant-colonel commanding the Calgary batallion of the Reserve Militia. He has always been a man of broad visions, fearless in his convictions, optimistic to a high degree and possessed of unbounded faith in the ultimate place that Canada will occupy among the nations of the world. He is characterized by his fairmindedness, and has always been a man of quick decision, based on a knowledge of facts. His accomplishments have been the result of a combination of sound judgment and unusual executive ability. His work has left an indelible impression on the history of the development of western Canada.



JOHN STOUGHTON DENNIS

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Run-Off Computations for 70,000-Acre Storm-Water Drainage, St. Louis

The report on storm-water drainage for the River des Peres district, by W. W. Horner, Chief Engineer of Design, adopted by the Board of Public Service of St. Louis recently, brings out clearly the method of sewer design now used in St. Louis. Its application to so large a project is somewhat unusual. (See *Engineering News*, Feb. 1, 1917, p. 209. The drainage area involved totals 70,000 acres.) An abstract of portions of Mr. Horner's report follows:

Up to 1907 St. Louis was using the McMath formula in its sewer design. The known irrationalities of this formula and the dissatisfaction with the results obtained finally led, in that year, to the beginning of a new study of rainfall in connection with sewer design, and shortly thereafter the formula was rejected in favor of an application of the rational method of design. In this respect the St. Louis experience was not greatly different from that of other cities doing large sewer work.

At that time the city secured all the available records of the St. Louis Weather Bureau station and from these prepared a rainfall curve that was used for several years. The data of the Weather Bureau, for short storms, extended back to only about 1900, and for the longer storms figures were not always given for the total precipitation in two and three hours. The city installed its own gages in 1910, and the record of these gages, together with those originally obtained from the Weather Bureau, later made it advisable to revise the curve first adopted.

The revised rainfall curve as now used in St. Louis is shown as a long dash line in Fig. 1. It will be noticed that the intensities on this curve have been exceeded at least once and in some cases three times for any particular duration, which would indicate that, if all other considerations of the design were correct, the sewers would probably be overcharged somewhat at intervals of about 15 or 20 years.

During the latest studies of the River des Peres scheme the question of allowing this drainage system to be overcharged at long intervals, as is permitted in the case of ordinary sewers, was reconsidered. Even though such an overcharge might occur only once in 25 yr. and even though the damage occasioned at such a time would be considerably less than the interest on the additional expenditure required to avoid it, the continually growing demand for a higher class of service from all improvements was taken into account, and it did not seem impossible that at some time in the future the sentiment following such an overcharge might force the provision of additional sewerage facilities. If this should occur, it would prove to be enormously expensive, particularly in the western part of the system; and it was therefore decided to recommend that the sewers be built to carry any flood that could reasonably be presumed.

For the purpose of the River des Peres design, therefore, a new intensity curve was prepared, which is the upper curve shown by a full line in Fig. 1. As shown by the plotted points, the intensities of this curve have been exceeded several times, but only for the shorter rains; and it was shown later that the design of the River des Peres system was not affected by the intensities within the 2-hr. time.

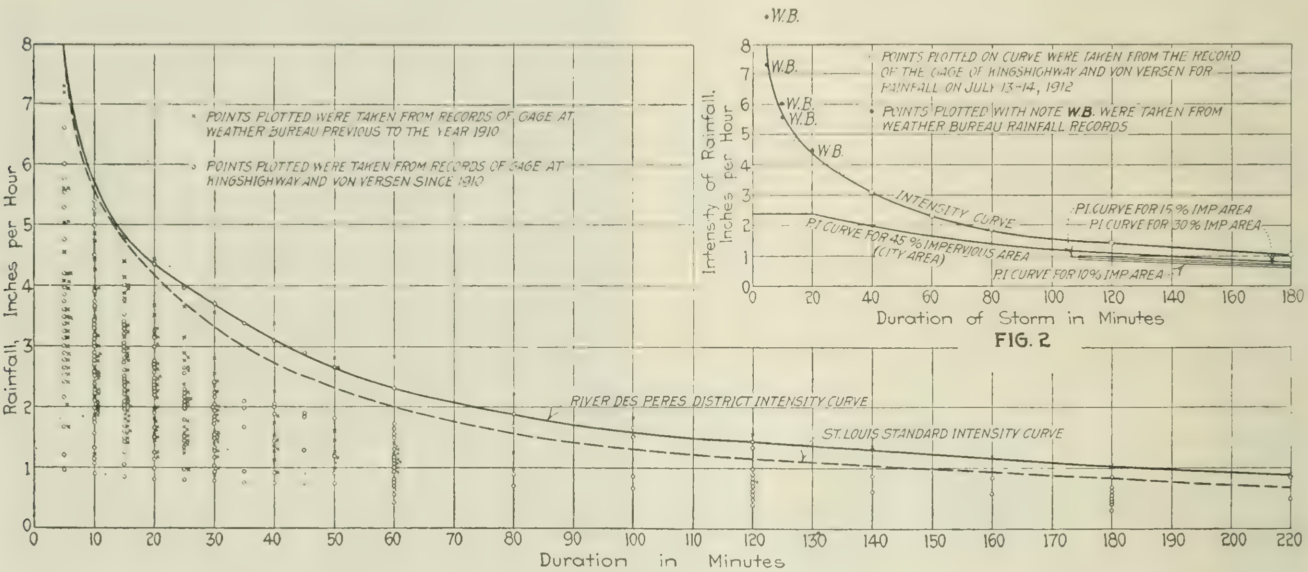


FIG. 1

RAINFALL INTENSITY AND RUN-OFF CURVES FOR SEWER DESIGN, ST. LOUIS, MO.

In the beginning of these studies the St. Louis engineers could find few reliable data on the measured run-off from sewer districts. Even the more recently published report from the Boston Society of Civil Engineers on this subject gives results that vary widely, and so many local conditions are involved that it is difficult to draw conclusions. St. Louis, therefore, in 1910 initiated an independent set of experiments on this subject and had a large number of sewer and rain gages installed in different drainage areas. These experiments have been continued on a large scale, but the data thus secured have not yet been completely analyzed. From a portion of the

TABLE 1. RUN-OFF FACTORS FOR VARIOUS PERCENTAGES OF IMPERVIOUSNESS

Duration Min.	% Run-Off from Impervious Portion	% Run-Off from Pervious Portion	Average % for Classes of Areas Having Following Amount of Impervious Area 10%	15%	30%	45%
10	50	20	22.0	26.0	32.0	38.0
15	70	30	31.0	36.0	42.0	48.0
20	80	35	36.0	41.75	48.5	55.25
30	85	40	40.5	46.75	53.5	60.25
60	95	50	49.5	56.75	63.5	70.25
120	95	60	57.5	65.25	70.5	75.75

TABLE 2. COMPUTATIONS FOR THE TIME OF CONCENTRATION OF THE NORTHERN BRANCH OF RIVER DES PERES AT THE CITY LIMITS OF 1876*

Station to Station	Average Area of Cross-Section, Sq. Ft.	Hydraulic Radius R, Ft.	$R^{0.62}$	Length, Ft.	Slope, Ft. per Ft.	n	Velocity, Ft. per Sec.	Time, Min.	Total Time, Min.
0+00 to 11+25									10 00
11+25 to 23+25	10	0.64	0.758	1,200	0.0187	0.035	4.6	4.35	14.35
23+25 to 42+75	12	1.04	1.006	1,950	0.01055	0.035	4.6	7.06	21 41
42+75 to 93+00	20	1.42	1.24	5,025	0.0084	0.035	5.0	16.75	38 16
93+00 to 167+25	80	2.42	1.73	7,425	0.0056	0.040	5.0	24.75	62.91
167+25 to 242+25	150	3.24	2.07	7,500	0.0034	0.040	4.7	26 60	89 51
242+25 to 254+25	280	5.00	2.71	1,200	0.00242	0.035	5.9	3.39	93.90
254+25 to 289+25	280	5.00	2.71	3,500	0.00242	0.025	8.3	7.03	100 93
289+25 to 333+00	450	6.50	3.19	4,375	0.00188	0.025	8.6	8.48	109 41
333+00 to 387+00	30 ft. horse-sh.	....	.....	5,400	....	0.013	12.1	7.44	116 85†

* The formula used in these computations is as follows:—$V = \frac{1.55}{n} \times R^{0.62} \times S^{0.50}$. † 116 min. is taken as the time of concentration.

records, however, it appears that a rather definite idea of the amount of run-off from sewers in the typical residence section in St. Louis has been gained.

In applying the run-off factors with the amount of impervious area taken into account the run-off coefficients for several values of impervious percentages were used as given in Table 1.

The intensity curve given in Fig. 1 is reproduced as the upper curve in Fig. 2, and by multiplying the ordinates to this curve by the run-off factors in Table 1 values are found for plotting the lower curves giving rates of run-off for various percentages of imperviousness.

It will be noticed that, because the percentage of run-off has been estimated to increase with the duration of the storm, the run-offs per acre vary but little for the long storms that are critical for the River des Peres. For that reason any errors in the assumptions of the future conditions of imperviousness will have a comparatively small effect on the amount of run-off.

While a large part of the River des Peres watershed within the City of St. Louis is sewered, only a small part of the county area is now thickly populated; and it was necessary to predict the probable growth of the city and the character of occupancy in that portion of the watershed beyond the St. Louis limits. In doing this, local conditions, the present trend of growth and transportation facilities had to be taken into account. In the final analysis the portion of the watershed of each branch near the city limits was assumed to reach a second-class urban development, and the percentage of imperviousness of 30 was assigned to this class. Beyond this a second portion of the area was assumed to become finally a large suburban community and was given a percentage of imperviousness of 15. It was decided that the remaining, or most remote, area would never be more than semirural, and the percentage of imperviousness was taken at 10.

In the application of these values by the rational method to the design of the main drainage system it was first necessary to determine the probable time of concentration of the flow at the city limits. For this purpose careful surveys were made of the natural channel between the city limits and the extreme watershed. The length of the channel, grades, channel section, high-water marks and lateral slopes of ground were obtained. In the computation of the time given in Table 2, it was assumed that the channel throughout the section of the first class mentioned above would be partly improved and that through the second and most remote sections nothing more than straightening would be done.

From Table 2 it was found that the time required to concentrate the run-off of excessive rains at the point where the channel first entered the city limits is 116 minutes.

With this value of 116 min. as the critical time at the city limits and the run-off factors for the various classes of impervious areas taken from the discharge curve, Fig. 2, the run-off shown by Table 3 results.

TABLE 3. SUMMARY OF AREAS TRIBUTARY TO END OF SEWER AT CITY LIMITS

	Sec.-Ft.
30% impervious, 1,752 acres at 1.01 sec.-ft. per acre	1,770
15% impervious, 3,591 acres at 0.96 sec.-ft. per acre	3,447
10% impervious, 4,700 acres at 0.92 sec.-ft. per acre	4,324
Run-off of North Branch at city limits	9,541

The resulting value, 9539 cu.ft. per sec., is very much greater than the discharge of any flood that has occurred to date; but it is clearly indicated, if the predictions of future development of the county territory are approximately correct.

The other county areas were treated in a manner similar to that given above for the North Branch.

The report shows that the run-off is much greater than any recorded for watersheds of similar size, but calls attention to the fact that there is no record of a watershed of this size which is sewered to the extent that this one would be; and if this is taken into consideration with the proposed development of the whole valley as industrial property, it is evident how great the damage might be in the future, if sufficient provision is not made at this time.

The largest size of closed sewer proposed in the report (a double arch of 29 ft. width) will carry nearly 14,000 cu.ft. per sec.

The Need of Topographic Maps for Aviators was explained by E. Lester Jones, Superintendent of the United States Coast and Geodetic Survey, in a paper read at the Pan-American Aëronautic Exposition in New York City, Feb. 9. It is well understood that as a means of coast defense the United States should have a large force of aëroplanes, which may be required to operate at any place along its coast. Where aviators cover long distances, as they are often obliged to do, the need of a good topographic map as a guide is very great. Unfortunately, a large part of the coastal area of the United States is still unmapped. There is no topographic map of any part of our Atlantic coast south of Norfolk, Va., and of many parts of the coast north of that place; nor is there a single place along the gulf coast where we have any topographic maps. An exception is made of the narrow strip of topography 3 mi. wide which is mapped by the Coast Survey in connection with its hydrographic charts, but this is too narrow to be of much service for aviation charts. From the pressure of other work the Coast Survey has not kept up its land-topography work in recent years. Mr. Jones further stated that there is a movement now in military circles to start the systematic mapping of a strip approximately 20 miles wide along the entire coast line of the United States, which appears to be the minimum amount that under modern conditions of warfare will be needed for the defense of the coast and the movement of troops along them. At places, this width of 10 miles must be increased to 40 or 50 miles. Mr. Jones also urged a large extension of wire-drag surveying to discover deep underwater reefs, which while not dangerous to ordinary vessels might prove fatal to submarines when operating submerged.

Railway Grade Changes in Two Cities

The elevation of tracks through cities is one of the most important duties now before railway companies and one that occupies most of the efforts of their construction forces today. In this article are described the main features of two such jobs, one at Jamestown, N. D., now about completed, and one at Aurora, Ill., now under way. The two constructions are somewhat similar, and each has some peculiarities in the concrete structural design.

New Station and Elevation at Jamestown

The improvements by the Northern Pacific Ry. at Jamestown, N. D., included the elevation and rearrangement of tracks, the construction of a retaining wall and a large street subway and the building of a new station. The work was done at the same time as the construction of a sewer system by the town, and the railway paid part of the cost of this instead of building its own sewer outlet to the river. This coöperation of the railway company and the municipality for their mutual benefit is an interesting feature of the work. The sewer system was described in *Engineering News*, Feb. 22, 1917.

Jamestown is a division point on the main line and the starting point of two branch lines (to north and south). As in many Western towns, the railway runs through the center, and there are two main streets alongside the right-of-way, with stores and hotels fronting upon the railway. The tracks have been raised for 2100 ft. east from 5th Ave., which is one of the principal cross-streets. The maximum elevation is 6½ ft. This change eliminates a sag in the grade and a enables a 60-ft. subway with 13-ft. headway to be put in at 2nd Ave. The main sewer of the new system crosses the railway at this street, and an outlet sewer runs along the south side of the tracks (on the railway right-of-way) west to the James River.

The new passenger station (Fig. 1) is at 2nd Ave., its east foundation wall forming a part of the abutment for the subway. It is 231x38 ft., with station facilities on the first floor, division operating offices on the second and engineers' offices on the third floor. The building is of wood framing with Hebron pressed-brick walls, blue Bedford stone trimmings and green tile roof. A passage and stairway lead from the main waiting room to the sidewalk in the 2nd Ave. subway.

The foundations for the building are concrete retaining walls at the sides and columns in the interior space, as shown in Fig. 2. The ground on the site of the station is 12 to 15 ft. below the new grade of the tracks, necessitating high foundation walls. These walls are of a thin reinforced-concrete type, the wall acting as a beam between the footing course and the concrete floor of the station, to both of which it is keyed and connected. The footing was carried down into a shale formation, and the concrete was poured directly into the trenches (without side forms), thus making a toe that is well anchored in the ground to resist inward thrust. The floor slab is 5½ in. thick, reinforced with wire mesh, and is formed monolithic with beams between the columns. The reinforcement of the wall (along its inner face) consists of horizontal bars 24 in. apart and vertical bars spaced 6 in. apart in the lower portion and 12 in. in the upper portion.

FIG. 1. NEW STATION AND TRACK ELEVATION ON THE NORTHERN PACIFIC RY. AT JAMESTOWN, N. D.

There will be two passenger and two freight tracks, two pair of stub tracks for trains of the branch lines and three coach-storage tracks. In front of the building is a platform 21½ ft. wide, with ends 13 ft. wide, extending between the main and stub tracks. There is also a 13-ft. island platform between the main passenger tracks. These platforms are 1100 ft. long, paved with brick, and have concrete curbs. The space between curbs is 9 ft. For cleaning cars on the coach tracks there are hydrants and boxes concealed in the island platform.

The main floor is at the track level and is reached by an inclined approach behind the station. This approach has a 10-ft. cement sidewalk and a 26-ft. roadway (with 54-ft. turning space) paved with sandstone blocks. The sidewalks and roadways are drained by side inlets to a drain under the sidewalk slab, with 12-in. vitrified-pipe connections to the storm-water sewer.

The 2nd Ave. subway, shown in Fig. 2, is 60 ft. wide, the full width of the street. It is of unusual length, 168½ ft., as it carries not only the tracks and platforms, but also the 54-ft. carriage space and 10-ft. sidewalk at the summit of the inclined approach. It is of reinforced

concrete throughout, with two side spans of 12 ft. and two middle spans of 20 ft., carried by three bents having arched openings between a series of rectangular columns spaced 7 ft. 5 in. c. to c. Beneath one of the roadways

To construct the slab spans, it was necessary to cut out the tracks two at a time, remove a temporary bridge at the site and pour the slabs up to the nearest expansion joint.

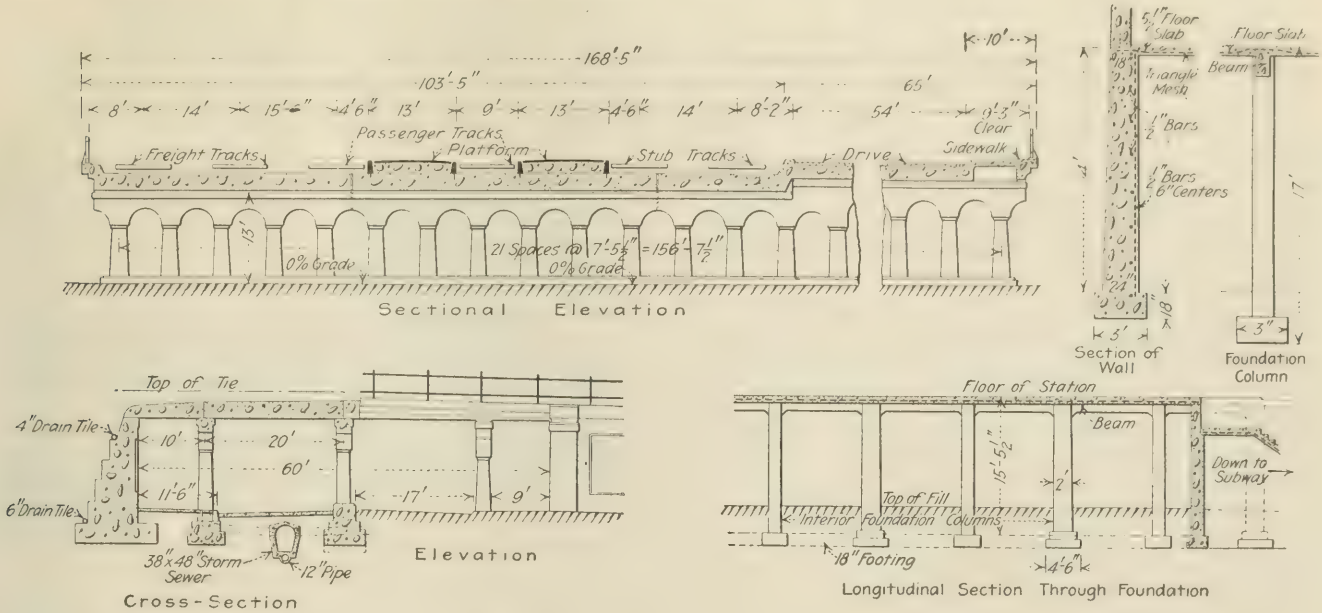


FIG. 2. DETAILS OF SUBWAY AND RETAINING WALL AT STATION IN JAMESTOWN

is a main storm sewer 38x18 in., with a vitrified-pipe domestic sewer below it.

The spans are reinforced-concrete slabs cast in place. Each span is made in four sections (with longitudinal joints), the two outer sections being about 40 ft. wide and the two inner sections 44 ft. wide. The ends are treated ornamentally and carry hand railings. The top of the deck has a waterproof covering and is sloped toward the ends to shed water. Drainage is provided by tile drains under the platforms and laid along the top and bottom steps at the back of the abutments and retaining walls.

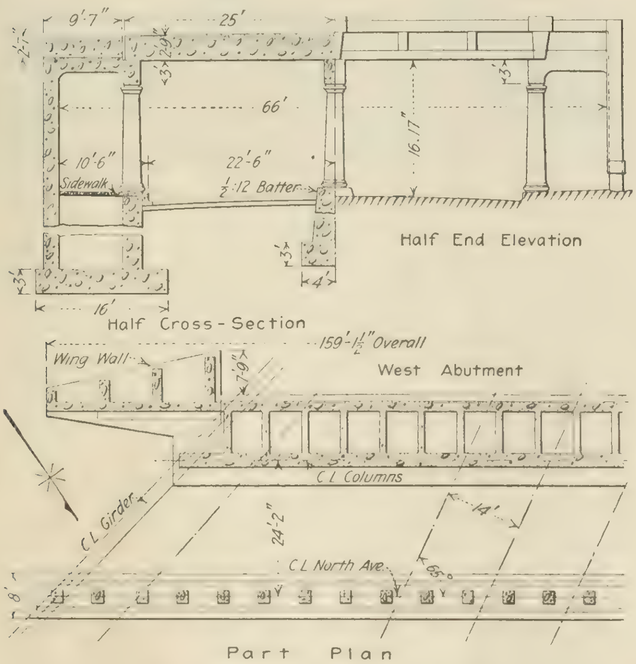


FIG. 3. SUBWAY OF REINFORCED-CONCRETE AT NORTH AVE., AURORA, ILL.

Note the special type of foundation for abutments and sidewalk bents

The total estimated cost of the work is $165,000, distributed as follows: Station, retaining wall and subway (contract price), $112,000; track and grade changes, $24,000; sewers and drainage on right-of-way, $8000; miscellaneous, $21,000.

The E. G. Evanstad Co. had the contract for the station, retaining wall and viaduct. Track and grade changes are made by the railway forces. The railway company also makes a voluntary contribution toward the expense of the town sewer system, the amount being equal to the cost of constructing the company's own outlet to the river. The work was designed and constructed under the direction of W. L. Darling, Chief Engineer (recently resigned), and H. E. Stevens, Bridge Engineer (now Chief Engineer), Northern Pacific Ry. Louis Yager is Division Engineer, and P. W. Stickney, Assistant Engineer, is in direct charge of the work. The sewer system was designed by L. P. Wolff, Consulting Engineer, St. Paul, Minn.

Railway Changes at Aurora, Ill.

The main line of the Chicago, Burlington & Quincy R.R. has a long sag in the grade line at Aurora, Ill., in order to pass through the city at the street level; and west of the river it has a long reversed curve location through an industrial district, with a bridge over the Fox River. The city has required the elevation of the tracks, and in connection with this the main line has been relocated for a distance of about four miles. This not only eliminates undesirable curvature, but improves the grades by reducing the sag. The maximum grade will be 0.3%.

East of the city a long easy curve will replace the present line and provide for a better arrangement of the freight yards. Through the city the old location is retained, but the line will be on a fill with retaining walls. The right-of-way is also widened for five tracks, involving considerable expense for property acquired. West of the city a relocation eliminates the reversed curves and

gives a direct line, crossing the river at an island and requiring a bridge for each channel. Near the river the new line crosses an abandoned stone quarry, requiring a considerable fill. The old line will be continued in service, as it serves a number of industries.

The two bridges over the Fox River have concrete arch spans of 65 ft. in the clear, with spandrel arches carrying a concrete deck. The one over the east branch has two arches, while the one over the west branch has three arches. These will carry five tracks spaced 14 ft. c. to c. The piers and abutments will be built of full length to above the ordinary water level, but the arches and upper parts of the piers will be built only for three tracks at this time.

The foundations consist of concrete cylinders 4 ft. 3 in. in diameter, built in open pits. For each pier there are two rows of cylinders, sunk to rock at depths of 25 to 35 ft. They are spaced 16 ft. c. to c. longitudinally and 9½ ft. c. to c. transversely. The materials encountered were gravel and clay. The foundation work will be carried on during the winter, but the arches will not be started until next summer. For this work there are three stationary mixer plants, with 1-yd. mixers and 98-ft. elevator towers supporting inclined steel chutes. Between the two bridges will be about 1300 ft. of ordinary fill, across the island.

The subways will have reinforced-concrete bents and abutments with decks of precast concrete slabs. The North Ave. subway shown in Fig. 3, is typical of these structures, except that it is of unusual length, carrying six or more tracks at various angles. A peculiar feature is that of putting each abutment and curb-line bent on a single foundation slab considerably below the street level, the space being subdivided by crosswalls under the sidewalk and ribs extending from the abutment to the columns of the bent. This design was adopted in order to reduce the amount of concrete in view of the fact that at this point the depth of foundations is about 20 ft. The columns are rectangular, with chamfered edges. The wing walls are of the counterfort type. Wood forms are used, except that for the molded bases of the columns there are cast-iron forms which are made at the railway company's shops. The uprights of the column forms rest on these castings.

This new work will cost about $4,000,000 and will be completed (for three tracks) in about two years. The construction is being done entirely by company forces. It was planned under the late T. E. Calvert, Chief Engineer, and is under the direction of W. L. Breckenridge, Engineer of Maintenance-of-Way. W. Pringle, Assistant Engineer, is in resident charge of the work.

An Investigation of Sewer Bids at Portland, Ore., by a committee of three members of the Oregon Association of Members of the American Society of Civil Engineers was recently requested by the City Council, acting on rumors of collusion in bidding. At a meeting of the Association to discuss the request it was urged that the estimate of City Engineer Philip H. Dater, was made in August, 1916, since when the price of materials, particularly steel, and of labor, has gone up; also that the work is hazardous and that the contract provides for no payment until the work is completed and accepted. For these reasons it is said that it is no wonder the lowest bid, made by J. P. Shea and William Lind, was 10 to 12% above the estimate, or $302,800 compared with $273,000. At last reports the Association was to take a ballot on the request, with the understanding that the three highest nominees would be designated as an investigating committee.

Using Light Motor Trucks for Construction Work

The use of the lighter class of motor trucks, similar to delivery wagons, for service on construction work is a special field offering extensive opportunities, but which as yet has not been developed to the same extent as the employment of large trucks (especially those of the dump-body type). Many builders make trucks of ¾-ton to 2½-ton load capacity, and there are special attachments by which automobiles can be converted into trucks of about 1-ton capacity.

These light trucks are strong and serviceable, with good overload capacity, and they are economical in cost of operation and maintenance or repair. It is obvious that for economical service a good and careful driver is essential, but it is astonishing what rough usage the trucks will stand, either in careless handling or in getting over rough ground. Very frequently they are run with light loads, when necessary to give prompt delivery of material, machinery, repair parts or men. In such cases time is the all-important factor. On the other hand, they not infrequently carry loads far above the rated capacity. Such trucks are operated mainly on paved streets and country roads, but can negotiate the rough tracks around construction work or even travel across country.

The bodies are of different types, but the most common form for this class of machine is the low-side box body. Typical designs are shown in Figs. 1 and 2, the former being an International truck with cab, and the latter showing some Overland trucks with automobile hoods. Tank bodies may be adopted for hauling water or oil. Dumping bodies are not frequently used, as it is rarely desirable or economical to handle excavated material in small lots.

On the other hand, for such jobs as excavation for buildings a contractor may find a light dump-body truck of assistance, especially if it is convertible into a delivery truck. A machine of this class with 1-ton side-dump body was described in *Engineering News,* of July 27, 1916.

The advantages in speed, range of action and readiness of service afforded by the light trucks have long been recognized by dealers in material and supplies, and also by municipal departments. The same advantages apply also in much construction work, and many contractors have already added such cars to their equipment. In building work especially their value is in being able to make prompt and frequent delivery and to serve a number of jobs. Their advantages over horse-drawn trucks are largely in ability to make numerous runs in the city or to make long and quick runs to distant jobs. The possible daily mileage is immensely greater than with a team. The team also must have periodical rest; and if horses are overworked (in speed, load or length of service), they require time to recover normal condition.

There is also the "emergency" advantage in making it possible to supply material quickly when needed, whether within or beyond the range of a team. The lack of drill steels, a few sacks of cement, a repair part, a little lumber, etc., may cause an expensive delay, holding up the work of a large crew. But with a light motor truck such troubles—which will occur on construction work in spite of all foresight—can be taken care of easily.

Some supply firms dealing in building material have found that having light trucks for long trips reduces the cost of delivery to such an extent that out-of-town jobs can be figured at lower prices than when teams were used. With the latter also there is likely to be unsatisfactory delivery in distributing materials to various buildings in different parts of a city. In fact, a dealer in such supplies has reported that a 1½-ton truck gives better service than three double teams and has practically eliminated complaints from customers as to delays in delivery.

FIG. 1. MOTOR TRUCK USED TO CARRY A CONCRETE MIXER AND BUILDING MATERIAL

A 2-ton truck is used by the Dravo Contracting Co., of Pittsburgh, Penn., for hauling supplies and machinery parts from the city to the company's works at Neville Island and from these works to various contracts in the vicinity of Pittsburgh. The average trip is 15 miles (in one direction) and the maximum about 25 miles. The hauling is done on city streets, country roads and the temporary driveways on the construction jobs. This truck is in constant service. A 1½-ton Kelly-Springfield truck is utilized by the T. J. Pardy Construction Co., of Bridgeport, Conn., in hauling building materials from cars to various jobs and to different cities. Most of the hauling is in towns, but some on country roads. The length of trip is ordinarily 2 to 5 miles, but trips from town to town may be 10 to 60 miles long. The cost of operation and maintenance is small, and the work is done so quickly that delays in supplying small quantities of materials are eliminated. It is estimated that this truck will pay for itself in 1½ to 2 years. Both the companies named above turn to the trucks occasionally to transport men.

FIG. 2. TWO LIGHT MOTOR TRUCKS USED BY A CONTRACTING FIRM

On tunnel work in New York the contracting firm of Booth & Flinn (of Pittsburgh) used a White truck to handle drill steels. The drills were sharpened at a central plant, and the truck distributed them to the various shafts and brought back the worn drills. A rather unusual service is hauling a concrete mixer from place to place. This has been done extensively by W. Polcyn, a Chicago building contractor, with an International truck (Fig. 1). A suggested modification of this plan is to mount the mixer permanently on a trailer, saving the time of loading and unloading the machine.

Still another interesting example is the operation of a Smith "Form-a-Truck" (converted from a Ford automobile) by the Thompson-Starrett Co., of Chicago, during the construction of houses for the United States Steel Corporation at Gary, Ind. There are 200 of these houses, scattered over different locations. The concrete foundations are of uniform design, and the forms are used over and over again. In moving the forms the motor truck effects a great saving in cost and especially in time as compared with a team. When the forms are stripped from one building, they are loaded upon the truck, with a crew of carpenters, and quickly taken to the next site and erected. The truck is used also in distributing materials to the different sites.

There is a reverse side to the question, of course, and one firm of contractors for public works reports that it has found motor trucks more expensive than team service. They have employed light trucks in transporting gangs of men for 8 or 9 miles and say that the only saving here was the men's working time. But this in itself may be an important saving in some cases. This firm believes that for hauls up to 4 miles materials can be transported 25% cheaper with teams than with motor trucks. It considers 6 miles as the minimum haul for trucks and that even then the roads must be first class if the trucks are to show a saving over transportation by teams. The factors of speed and frequency of service are not mentioned and perhaps were not important.

It is difficult to make any close comparison of cost of service with motor trucks and horse wagons, but the former has been estimated at 30 to 50% the cost for the latter. But the greater speed, the possibility of more frequent service or of covering a greater mileage and the fact that the machine is ready at all times may be quite as important as a saving in cost. For a 1-ton truck costing $1525 the fixed charges and operating expenses have been figured at $591 and $1857 per year. This is compared with $1370 for the cost of two double teams and wagons, and annual charges of $891 and $3240. On a basis of 313 working days these figures show a total daily cost for fixed and operating charges of $7.82 for the truck and $13.20 for the teams.

The light motor trucks are of advantage also in municipal service and are used by water-works and other departments in transporting supplies and men. They make excellent supply and repair wagons (with or without towers) for electric-railway, telephone and telegraph companies.

Closely related to the selection of light motor trucks to serve construction work is the use of automobiles by engineers and superintendents on such undertakings. In this way they can cover more jobs and still give more time to each than with the horse and buggy equipment that is now becoming obsolete. The automobile also has the same "emergency" advantages as the motor truck in speed and readiness for service. In fact, one large firm of contractors says it would no more think of conducting its business without its automobiles and light delivery trucks than without telephone service.

Classification Surveys for Assessment Purposes in California

By Earl A. Marshall*

Classification surveys of agricultural lands for assessment purposes has recently become the practice among county and state officials in California. This work has consisted of making soil and topographic surveys and maps, to show the boundaries of the different types of soils, and grading them as numbers 1, 2 or 3 of each type, or as unfit for cultivation, and showing all areas in permanent crops, such as orchards, vineyards, alfalfa, hops, etc. All important topographic features are also shown, such as streams, dry channels, irrigation or drainage ditches, levees, roads, buildings, fences, brush or timbered areas, gravel bars, etc.

These maps have been made by compass and pacing surveys, platted in the field. The finished maps have been made on white paper with colored inks and show all soil acreages, acreages in each permanent crop, in county roads, right-of-ways, etc. The maps of a given area are accompanied by a report on the soils of that area, discussing for what crops they are best adapted, comparing their values, discussing irrigation or drainage possibilities and giving other data of value.

In California the type of soil is the most important consideration in fixing land values; yet heretofore it has been taken into consideration by the assessors only in a very indefinite way, if at all. In many cases the same type of soil at one end of a county is assessed twice as much as at the other, even though at the same distance from market; in other cases all the lands of a certain district are assessed at the same rate, even though certain soils there may be worth five times as much as others. The inequalities shown up have been so great that it is the intention of the State Tax Commission to recommend that the next legislature adopt a bill providing that the counties classify their lands, under state supervision. The methods that will be recommended are those described here.

Instruments Used and Methods of Fieldwork

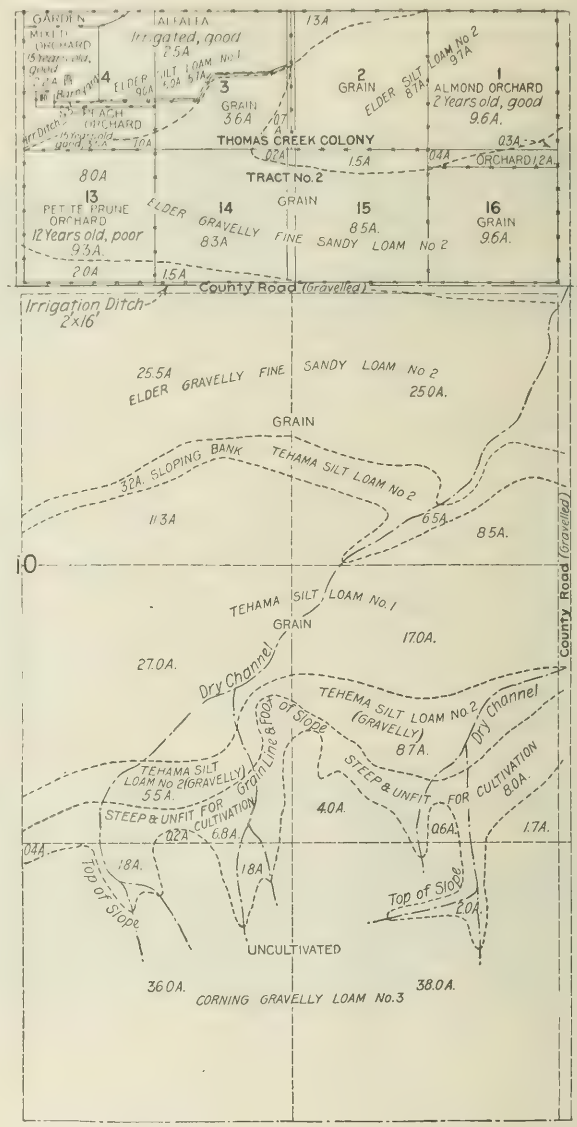
As before stated, the fieldwork is done by compass and pacing surveys, the topography being platted in the field. As a base to work from, all deeds, recorded surveys, or private surveys if obtainable, are platted on the map before entering the field. Where no better information is obtainable, it may be necessary to work to the original Government public-land survey; if this is badly in error, certain lines should be chained.

For taking the topography either a sight compass on a Jacob's staff has been used and the map platted on cross-section paper, or a traverse plane table similar to that of the United States Geological Survey has been used. The traverse table is the best and most convenient. Even with it, however, it is often easier to take unimportant bearings with a box compass held in the hand and plat them with a protractor. The scale used has been 16 in. to the mile, or 1 in. = 5 chains = 330 ft. By the use of cross-section paper no platting or scaling is necessary for lines run north and south or east and west.

Where the entire section is agricultural land, the examiner usually goes along the "forty" lines, covering a strip of 660 ft. on each side. He plats the position of all required objects accurately, pacing out for side shots the entire 660 ft. if necessary, and returning to carry the main line along. If he is surveying along a creek or bank, he usually traverses it, platting as he goes. For this it is best to have a scale of paces.

Where possible, the surveyor goes east, west, north or south for the side shots. Unimportant or indefinite boundaries are usually sketched. On the return, on a line parallel and a quarter of a mile over, the surveyor

*507 Concord Building, Portland, Ore., and 1619 L St., Sacramento, Calif.



SAMPLE LAND-CLASSIFICATION MAP

Original map is 10 x 17 in. The legend reads as follows:

EAST ½ OF SEC. 10, T.24N.R.4W., MT. D.M.
TEHAMA COUNTY, CALIFORNIA
E. A. M. Aug., 1916.

CONDENSED REPORT ON SOILS

The Elder Silt Loam is a smooth textured silt loam, easy to cultivate, and very retentive of moisture. It is well adapted to apricots, peaches, almonds, etc., and alfalfa. Irrigation is desirable, but not necessary. The value of the unimproved land is about $150 per acre.

The Elder Gravelly Fine Sandy Loam contains some silt, and will retain moisture well enough to produce peaches and almonds without irrigation. With irrigation it will raise almost any deciduous fruit, alfalfa, etc. The value of the unimproved land is about $90 per acre.

The Tehama Silt Loam is an upland soil, and, though a fair grain soil, will not produce fruit or alfalfa successfully without irrigation. With irrigation, however, it does fairly well. The value of the unimproved land is about $45 per acre.

The Corning Gravelly Loam on this section is underlaid at a depth of from one to two feet by a heavy, impervious clay. It retains moisture very poorly, but will raise grain in favorable years without irrigation. The value of the unimproved land is about $15 per acre.

can check his work by returning to the same points. The reason for running through on the "forty" lines is that they are usually fenced, which saves running a compass line. Where the agricultural land consists of a creek valley in the mountains half a mile or so wide, the surveyor usually goes back and forth across the valley, returning on each trip to check up. Where the ownerships are by irregular metes and bounds surveys, as they are in many of the old Spanish land grants, no particular system can be followed.

Methods of Classifying Lands

Other details not previously mentioned are shown on the map, such as the variety of orchard or vineyard, the approximate age, whether in good, fair or poor condition, etc. Annual crops such as grain, corn, hay, sugar beets, etc., are shown to be marked on the finished map in pencil. The cost of clearing all brush or timber land is estimated and the value of all buildings appraised. Size of all irrigation or drainage ditches, condition of roads, levees, etc., depth to water in wells or any other obtainable data of value are given.

The recognition and grading of soils are not very difficult. In all but Shasta County the soils have been named in accordance with the soil surveys of the United States Department of Agriculture. The soils of the various series are given names descriptive of their physical composition, such as Sacramento silt loam, Sacramento fine sandy loam and Sacramento fine sand. Naturally, a river does not deposit three types of soil of entirely uniform physical and chemical composition and with distinct boundaries. Consequently, these soils often merge gradually into each other without any distinct line of change; and with large bodies of soil, for instance, this mixture might be described as sandy silt loam or as fine sandy loam containing a high percentage of silt.

It is here that the grading by numbers comes in, as a sandy area of Sacramento silt loam, being less valuable, would be numbered 2 or even 3; and likewise, as Sacramento fine sandy loam approached Sacramento fine sand in composition, it would be numbered 2 or 3. Often, however, the boundaries are abrupt, being marked by a bank or slough. Different kinds of soils are picked by their physical appearance and not by the analysis of samples, as is sometimes thought. Samples for analysis should be taken from representative areas.

In certain cases the difference in soils occurs beneath the surface, so that borings must be made to find the boundaries. In areas underlain by hard pan, the grading of the soil depends on the depth to hard pan, and also upon whether the chemical composition of the hard pan is such that it will disintegrate under the action of water when broken up by blasting. In most cases changes under the surface are indicated by the appearance of the vegetation. Conditions of drainage, presence of gravel, roughness of the surface, etc., are also considered in the grading.

Alkali is another important consideration in California soils. Surface alkali, which affects shallow-rooted crops, is usually shown by the presence of certain weeds. The variety of these shows approximately the percentage of alkali present. Alkali well under the surface, which will affect alfalfa, fruit and other deep-rooted crops, is determined by electrolytic instruments.

The finished maps have been made on a good quality of white paper by tracing them direct from the field maps. This is done over a piece of plate glass set in a drawing table, with an electric light underneath. Section lines, lot lines, property lines, etc., have been shown in red; soil lines, names and acreages in green; and creeks, ditches, etc., in blue. Orchards and vineyards have been colored pink; alfalfa, green; brush and timber, brown. Areas of permanent crops, roads, ditches, etc., have been in red. Ownerships have been marked with colored pencils. Irregular areas have been figured with a planimeter; regular areas, such as rectangular orchards, by scaling.

The actual cost of the completed maps has ranged from about 3c. an acre for large areas cultivated mainly to grain to a maximum of 6c. an acre in the diversified farming regions of the Sacramento bottoms. The office work has cost almost as much as the fieldwork.

Maps such as described here are valuable for many purposes besides assessment. They would furnish information to prospective buyers of land and would retard to some extent the promotion of fraudulent colonization schemes. They would be of use to many state departments, to the United States Government in the matter of rural credits and to banks in making loans. For the promotion of a large irrigation project, especially one that included small areas already irrigated and successfully farmed to fruit and alfalfa, these maps would be invaluable. They would also afford a means of computing the prospective revenues of a proposed railroad and the future possibilities. Many such projects which have failed of promotion might have succeeded had they been accompanied by maps as complete as those described here.

Engineers for Oregon Cement Mill

In the article entitled "Electric-Driven Cement Mill of Oregon Portland Cement Co.," published in *Engineering News,* Dec. 21, 1916, p. 1194, the author, D. C. Findlay, said: "The entire civil, electrical and mechanical construction was designed and supervised by the author." This statement does not give proper credit to those connected with some earlier design and construction at the same plant. Mr. Findlay prepared the article as a description of the electrification of the mill only and included the offending sentence with the understanding that its application should be only to that part of the plant.

The plant was started some years ago by the Cement Engineering Co., of which L. D. Gilbert, of Victorville, Calif., was Chief Engineer. After it was well along toward completion another company took charge of the construction, and Mr. Findlay's connection began at that time. The wet process, involving the raw mill and the kiln building, was designed by F. L. Smidth & Co., and the remainder of the engineering work up to the time of Mr. Findlay's connection was under Mr. Gilbert's direction. Mr. Gilbert was also the erection engineer for the earlier owner, and in that capacity had charge of the construction or erection of the plant trackage, crushing machinery and most of the storage bins and of the raw mill. Under Mr. Findlay's direction the mill was completed and the entire electrification, elevating and conveying installation and the rotary-kiln installation were placed, utilizing a great deal of the earlier designs and of the Smidth equipment.

Financing Water-Supply and Sewerage Connections and Plumbing

By R. A. Butler† and F. C. Jordan‡

When Moses, who appears to have been the first sanitarian of whom we have any authentic record, laid down a code for living and being clean, he fitted his laws to both the rich and the poor. He said that if the unclean person was too poor to sacrifice a sheep or a goat on the altar, as a part of the purging process, he might sacrifice a fowl. A sacrifice was necessary to cleanliness then, just as in the present day. But, unlike the present day, the sacrifice might be of two values—one for the rich and one for the poor.

In this day, however, there are not two prices for the water service necessary to the sanitary disposal of water. Nor is there any considerable deviation in the price of bath tubs and plumbing. Each demands sacrifice, easy for the rich and prohibitively difficult for the poor.

The inability of many to contribute to the sanitary progress of all should not be confused with ignorance or lack of interest in proper sanitation. We may not agree that all persons would rather be clean than unclean, but we must confess that every individual values his health; and the great majority value the health of the community as a whole.

The little home, with its well water-supply, its lack of sewers and its open vaults, must give way to water service, sanitary sewers and sanitary closets. Some way must be found to finance these improvements without throwing too great a burden on small property owners.

Water and Sewer Facilities Made Easy

Have not the distributors of automobiles pointed the way for the distribution of sanitation? Today, if you wish, you may go to any dealer in automobiles and purchase a car by the payment in cash of half or less of the list price. A funding company will supply the rest of the purchase price and so arrange the deferred payments that you may make one a month for a reasonable period. The automobile is delivered to you under a lease, and the title remains with the funding company until the last payment is made. Insurance, interest and brokerage make this an attractive investment from the standpoint of the funding company, and the everlasting longing of the American purchaser for more luxury is the incentive that makes the business possible.

Why not apply the same principle to sanitation? Why not make it possible for the man who owns a small property to have sanitary plumbing installed in his home and the cost thereof extended over a reasonable period?

Electric light companies are wiring homes and gas companies are installing ranges on the installment plan. They have the sales and the collection systems already in operation, and the addition of appliance accounts is simple and involves little cost.

This same method of financing can and will be applied to water service and modern sanitary improvements in the near future. It is a problem that confronts water companies all over the country, and it is a solution that means more services on their mains, the use of more water and the improvement of the health of whole communities.

The water utility that undertakes plumbing as a side issue, for the purpose of intensifying its patronage, will encounter difficulties in the way of criticism. It may be denounced as a grasping corporation seeking to establish a trust in the plumbing business. But the fact remains that because of its buying power, its credit, and the ability to wait for its profit and take it in increased water consumption, it will be able to give to the property owner more satisfactory plumbing at less cost than it can now be obtained.

In Indianapolis there is an outlet from the mains of the water company for every 7.5 persons in the city. The average size of a family is five. It follows that the business of the water company is 33⅓% less than it might be. This one-third represents the field of prospects, and any merchandising expert will say that one-third of the whole of a city's population is a desirable field to cultivate.

With one-third the city as the field there is necessary to the development of business, capital sufficient to equip the possible user of water for its enjoyment. The installation desired in the class of homes in the city that now have no water service has been estimated at a physical cost of from $100 to $250, according to size and location. Taking the lowest figures as a basis, interest at 6% for two years and a brokerage charge of 6% could be added, and the installations made at a partial payment cost of $4.92 a month for 24 months. To this should be added the cost of water, not exceeding $1 a month, making in all a charge against the property of $5.92 a month, or approximately 19.7c. a day. This should prove a fairly attractive proposition for the man with a small property whose concern is a safe water-supply, such as is furnished by water utilities.

Leasing Plumbing Fixtures

Turning now to sewerage facilities, it may be noted first of all that the cost of plumbing fixtures in a modern home is not the major item of expense, but the fixtures are the necessary item to the enjoyment of sanitation. It is urged by plumbers and others that no property owner who has once had plumbing fixtures installed can afford to have them removed from a house. The removal is attended by such wreckage that the property would depreciate in value to a point far in excess of the cost of the fixtures and the labor necessary to sanitary plumbing. It is argued that an owner who has profited by better rentals or greater conveniences would exhaust every resource rather than suffer the removal of plumbing fixtures which have only recently been installed. Consequently, those who have investigated the credit problem maintain that a lease drawn to cover the fixtures installed in the house and affording legal right to enter and remove these fixtures in event of noncompliance with the terms of these leases would in practically all instances be sufficient protection for capital, no matter how timid it might be.

Funding Company Proposition

Organization and operation of the funding company is possible at a very small overhead cost. The amount of capital actually necessary is dependent on the size of the field, but a consideration not to be overlooked is the fact that each month brings part of the capital

*Condensed from a paper read before the Indiana Sanitary and Water-Supply Association, February, 1917.
†The Jenne-Butler Co., Indianapolis, Ind.
‡Secretary, Indianapolis Water Co., Indianapolis, Ind.

back for reinvestment, and with each monthly payment the individual account becomes more secure.

Operating expenses of the funding company would consist of three branches: Promotion of business, investigation of risks and collection. The expenditure necessary for the promotion of business will depend on the method of operation finally adopted.

In the automobile business it has been found more desirable to have the funding company separate from the sales agency, in name at least. Perhaps this would be more advisable in sanitary funding. Certain it is, that if the funding company were holding out to each plumber an opportunity to do work and collect his money immediately, even though the employer is not in a position to pay him cash, every plumber in the community would become an enthusiatic salesman, and the cost of sales would be greatly reduced for the funding company.

The ideal situation seems to involve the organization of a company with sufficient capital to be able to say to the property owner: "Hire any plumber you choose and select any fixtures you desire. We will pay the entire cost and give you two years in which to pay us."

Then, with the plumbers of a city the enthusiastic boosters of the funding company, the examination of the risks is the next important operating detail. It has been estimated that this work can be accomplished at a minimum fee of $5 a risk. The burden of showing title to the property is to be thrown on the applicant for a contract, and extensive investigation is not necessary. A manager of ordinary intelligence would be capable of judging the advisability of the contract, and a single inspection of the property should be sufficient to satisfy him. The time element is not important, and his work could be so distributed as to make it least expensive.

For convenience of collection, the water rental and the partial payment should be payable at the same place, the lessee being billed for the total, and the utility holding the funding company being responsible for the water rental. A simple card system of bookkeeping and a stenographer supplied with suitable letter forms for prodding the delinquents should accomplish the collections without great expense.

Enlisting the Small Property Owner

Whenever it is possible for the small property owner to improve his property without shouldering a hardship in the form of a big initial expenditure, it will be easier to insist on sanitary improvements. Laws designed to wipe out open vaults and unsafe wells will not be assailable on the ground that they are confiscatory. Property owners will benefit by increased value of their holdings. Renters will find properties more desirable. Water utilities will cut down their fixed charges as they increase the number of their patrons. Improved sanitation will bring about better health, and there will be far more individual effort toward community health.

A Combined Technical Association and Labor Union is the Civil Engineers and Surveyors Assistants Association, of Chicago, which is affiliated with the American Federation of Labor. A circular issued by the association states that although these men are technically trained and have considerable capital invested in their educational equipment, they often receive less pay than the laborers working under them. The assistants have organized therefore in order to secure compensation more in accord with their responsibility and training. The secretary is Le Roy Brown, 1435 North Oakley Boulevard, Chicago.

Suggestions for Selecting and Testing Drill Steel

By Frank H. Kaiser*

Mining with rock drills has progressed to a point where the actual efficiency of the drilling operation depends more on the drill steel than ever before. In order that the steel can meet these conditions, one must be able to obtain a uniform quality of steel and be able to subject the steel to the proper treatment. There must be means of doing this from day to day. As a suggestion for meeting these conditions the facts in this article are presented.

Although the chemical qualities of steel have a great influence, the analyses of drill steel are practically standardized. A chemical laboratory would be a good asset, but it is not essential for this work. When the proper heat-treatment has been given to the steel—assuming the steel to have the chemical properties as specified for standard drill steel—and the treated steel is either too soft or gives exceptional service, a sample of it could be sent to a commercial laboratory for chemical analysis.

Drill steels are made by both the openhearth and crucible methods. The crucible-made are lower in phosphorus and sulphur as a rule, while theopenhearth is lower in silicon. For each grade in either make, the carbon content will vary according to the size of the steel. In general the average analysis of a drill steel would show:

	%	%
Manganese	0.25 to 0.40.	Some makes as low as 0.15
Phosphorus	0.01 to 0.025.	Some makes as high as 0.04
Sulphur	0.015 to 0.025.	Some makes as high as 0.04
Silicon	0.10 to 0.20.	Some makes lower
Hardness (as received)	40 to 50 scleroscope or 225 to 300 Brinell	

The carbon content will vary as follows, as to shape, size and make:

	% Carbon
American-made octagon	0.80 to 1.00
American-made cruciform	0.80 to 0.95
American-made hexagon and round hollow	0.70 to 0.85
American-made solid and hollow spiral	0.70 to 0.85
F.J.A.B. No. 7	0.65 to 0.80
F.J.A.B. No. 10	0.90 to 1.05

It is advisable in selecting a drill steel that either a steel company or a drill manufacturer be consulted, as their experience fits them to suggest the best steel for the conditions. Request the steel company to give the critical range of the steel and the proper forging, annealing and hardening temperatures.

Each bar of drill steel as received should have a 3- or 4-in. test piece cut off and the piece and bar numbered. In this way a record can be kept of when the bar was received, from whom and the service given. Determine the Brinell hardness on the cut end of the test piece and then subject the piece to a simple forging operation, heating to the recommended forging temperature. Anneal the piece as recommended and then harden, using the recommended temperature and quenching medium. If the steels as used are drawn or tempered, the test piece should be heated to the same drawing temperature. Determine the Brinell hardness on this properly treated test piece, then break it and examine the fracture, noting the grain. If the fracture shows a seam or pipe, the bar should be rejected.

Each drill steel made should bear the same number as the bar from which it is made, and a record should be kept of the service of the drill steel. In this way a

*Metallurgist, Sullivan Machinery Co., Claremont, N. H.

record will be had of the Brinell hardness of the steel as received, the complete heat treatment, the hardness of the heat-treated steel and the service of the steel in the mine. After a hundred or so tests have been made, some of the high, medium and low Brinell test bars and those giving the best service can be analyzed. In this way a standard specification can be determined for the drill steel best suited to meet the conditions of the mine, giving the desired carbon range (10 points) and the Brinell hardness range.

The essential equipment consists of the following: Brinell testing machine; furnace for heating the steel, equipped with pyrometer; quenching tank; tempering or drawing bath; means of forging. Except the testing machine, this equipment can be found in the blacksmith shop.

Hints as to Apparatus

Gas or oil-fired furnaces of the muffle or semi-muffle type give the best results and are easily manipulated so that a constant temperature can be maintained. Furnaces should be adapted to meet the conditions.

Pyrometers are essential. Base-metal couples should be used either with galvanometer or potentiometer. Use equipments that automatically take care of the cold junction. Both the Wilson-Maeulen base-metal equipment and the Leeds & Northrup potentiometer equipment have proved serviceable. Adapt the pyrometer equipment to the conditions.

Place the base-metal couple in an X or XX iron pipe plugged or welded shut at one end, then place this in the chamber of the furnace as near to the drill steel as convenient. The indicating instrument should be somewhat away from the furnace, so placed as to be free from vibration and excessive changes in temperature.

The pyrometers should be checked weekly at least. One base-metal couple can be kept as a standard and compared with the one in service. When the regular one shows too great a variable error, use the standard as regular and purchase a new couple to use as standard. The indicating instrument should be sent away periodically to be tested and regulated. Complete information and instructions should be obtained from the manufacturers at the time of purchase.

It is not essential to have an equipment for determining the critical range. Obtain this range from the steel maker. The hardening heat is higher than the critical range and depends on the shape and size.

Hints as to Treatment

The following table will show the approximate critical ranges and hardening temperatures of steel relative to the carbon content:

Carbon Content, %	Critical Range, F.	Hardening Temperature, F.
0.60	1,340 to 1,380°	1,400 to 1,460°
0.70	1,340 to 1,375°	1,400 to 1,450°
0.80	1,340 to 1,365°	1,390 to 1,450°
0.90	1,340 to 1,360°	1,375 to 1,450°
1.00	1,340 to 1,360°	1,375 to 1,450°
1.10	1,340 to 1,360°	1,375 to 1,430°

The forging temperature for drill steels should be from 1550 to 1600° F. Do not continue the forging operation after the steel fades from a red color, as forging a steel cold or below its critical range distorts the structure and tends to produce brittleness. Reheat the steel, if necessary, to finish the forging operation.

In annealing, heat the steel just above the critical range and cool slowly. In hardening, if the steel is rapidly heated, it should be held just long enough to heat thoroughly. Uneven heating results in a soft center. On the other hand, the steel should neither be held too long at the hardening temperature nor soaked, as such treatment opens the grain or enlarges the crystals, tending to brittleness.

The quenching bath should be large and deep. Clean water is a suitable quenching medium, but for uniform results it should be kept at 60 to 80° F. After the steel is quenched, it is in its hardest condition, with a tendency to be brittle; accordingly, it will not well resist shock. To obviate this, it is well to draw the temper, thus sacrificing a small amount of the original hardness for a like gain in toughness. The temperature to which the steel should be drawn will depend on the condition of the rock. This must be determined by experimenting. The drawing temperature will vary from 350 to 600° F. Use a heavy or 600° fire-test oil for the drawing medium, reading the temperature with a thermometer. The "Tycos" armored thermometers, of the Taylor Instrument Co., Rochester, N. Y., are suitable.

In treating the shank end of the steel, after forging and annealing, heat to the proper hardening temperature and quench in oil. The oil tank should be large and the oil kept at a uniform temperature by circulation through a coil surrounded by water or by circulating the water through a coil around the inside of the oil tank. No. 2 soluble quenching oil, made by E. F. Houghton & Co., Philadelphia, Penn., is suitable. When the steel has reached the temperature indicated by the pyrometer, the color of the heated steel will be the same as that of the iron pipe in which the base-metal couple is in direct contact with plugged end inserted in the furnace.

In conclusion I desire to urge coöperation with the steelmaker in all drill-steel troubles, as I believe the steelmaker is as anxious to give satisfaction as the user is to obtain it.

Liquid Chlorine Proves Superior to Hypochlorite

Liquid chlorine cost much less and effected more bacterial reduction than hypochlorite and was in other respects more satisfactory on one installation, according to a paper by M. S. Dutton, of the Central Illinois Public Service, Lawrenceville, Ill., before the Illinois Section of the American Water-Works Association, Mar. 13-14.

With hypochlorite at 7c. and liquid chlorine at 20c. the average cost of hypochlorite treatment for January was $1.07, compared with only $0.28 per 1,000,000 gal. for liquid chlorine.

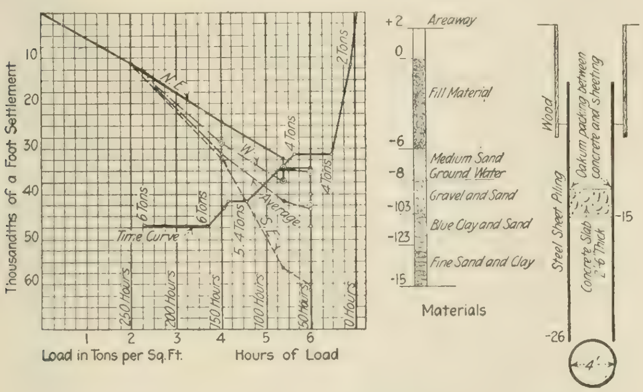
The average reduction in bacteria count of daily plates made on nutrient agar incubated at 37° C. for 24 hours, was as follows: In January when hypochlorite was used the average raw-water count was 6300 and the filtered-water count was 15. In June, when liquid chlorine was used, the average raw-water count was 7980 and the filtered-water count was 11. In B. Coli tests, the raw water shows 100% for each month, while the filtered water shows 1.6% in January and 0.0% in June. These results were obtained by means of 1 c.c. samples in all cases. Also note that while hypochlorite was used 0.46 p.p.m. of available chlorine was applied and while using liquid chlorine 0.22 p.p.m. of chlorine was applied.

Notes from Field and Office

Bearing test on wet sand confined by steel sheet piling—Siphoning water over a 95-ft. barrier—Detail index in a structural engineer's office—Unusual operation at an Ohio River dam

Bearing Test on Confined Wet Sand

A concrete slab-and-girder mat, with the wet treacherous sand underneath confined by a ring of interlocking steel sheet piling, supports the new boiler house and coal-storage plant of the New York Steam Co., at Burling Slip and Water St., in downtown New York City. The load of the boiler room averages 2.6 tons per sq.ft. of the entire foundation; for the coal-plant mat the load is 5.4 tons. Before the Building Department would permit such a foundation to be laid, it had to be convinced by tests of the safety of the method. The sketch shows how the loading test was made and gives the settlement by curves.



LOADING TEST FOR UNUSUAL FOUNDATION

The test arrangement is really a model of the foundation proposed. A steel sheet-pile box was driven to a depth of 26 ft. below curb and the material inside excavated to a depth of 15 ft. A concrete slab $2\frac{1}{2}$ ft. thick was placed on the sand bottom below groundwater. The slab was loaded with pig iron to give a maximum load of 6 tons per sq.ft., and readings were taken on the four corners. The greatest settlement after 237 hours was 0.061 ft., the average settlement for this period being 0.047 ft. The time curve shows that there was no settlement between load applications.

After this satisfactory test, the foundation mat, designed by Daniel E. Moran, consulting engineer, was constructed by The Foundation Co.

Mechanical Siphon Forces Water Over 95-Ft. Summit

By J. W. Swaren*

The writer recently inspected a mechanical siphon in western Idaho, consisting of a motor-driven centrifugal pump and a generator driven by a Pelton waterwheel, which is worthy of brief record.

*R. R. 2, Box R, Hayward, Calif.

In 1914 the increasing demands on the Lewiston-Sweetwater Irrigation Co., of Lewiston, Idaho, made it necessary to divert additional water into Sweetwater Creek, on which the company had depended. It was decided that Lake Waha was the most economical source; this body had been formed by a landslide and had no visible outlet, evaporation and seepage balancing the inflow. It was decided that a daily draft of 10 sec.-ft. could be taken through the irrigation season.

Tunnel schemes of getting the water past a 95-ft. barrier were abandoned in favor of a mechanical siphon. A centrifugal pump having a capacity of 10 sec.-ft. against a head of 145 ft., when driven at 1170 r.p.m., was installed near the water's edge. It is direct-connected and mounted on the same sub-base with a 250-hp. 2300-volt wound-rotor-type induction motor. This unit is mounted on concrete piers; two groups of these are provided to accommodate the lower level of the lake as the season advances. In the spring of 1917 the pumping unit will be mounted on a car running on a track extending into the lake, and the car will be raised or lowered by a windlass.

A 20-in. flanged-joint suction line, 120 ft. long, made of $\frac{1}{4}$-in. riveted plates, extends into the lake. The electric control apparatus is housed in a separate building. This includes a starting-contactor panel, which prevents over-acceleration of the motor.

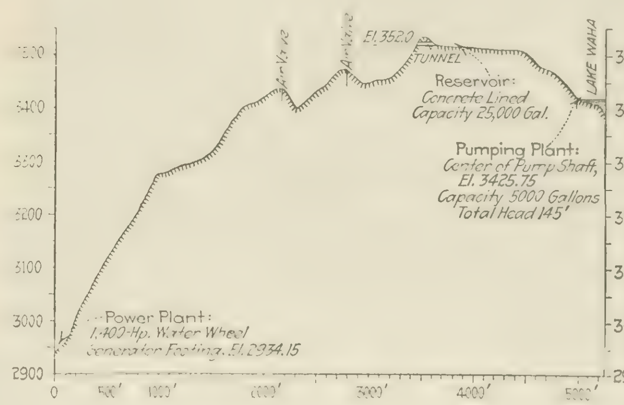


FIG. 1. PROFILE OF LAKE WAHA SIPHON

A 30-hp. gas engine is installed for driving a vacuum priming pump, and a 4-in. centrifugal is used to fill the discharge pipe, the reservoir at the summit and the penstock. This is necessary before the hydro-electric pumping combination can be started.

A 20-in. 16-gage slip-joint line 1650 ft. long leads from the pump to a balancing reservoir near the canyon rim and at the summit of the hydraulic system. At this point a reinforced-concrete reservoir 8 ft. deep and 50 ft. long has been built. Its bottom is at El. 3520. A float gage actuates the contacts of a circuit formed by

utilizing the telephone line connecting the power house and the pumping plant, promptly sounding an alarm if the level in the reservoir changes 6 in. Normal level is just below the spillway; and should it drop 5 ft., air will be drawn into the penstock. The reservoir eliminates trapping of air at the summit of the pipe system, and shutdowns are made in the irrigation season only to change the pump setting or for inspections.

At El. 3520 a 5 x 3½-ft. tunnel 51 ft. long pierces the canyon wall. The penstock, laid in this tunnel, leads directly from the reservoir. It is 15 in. in diameter, with a total length of 3484 ft. Of it 1890 ft. is 16-gage slip-joint; 358 ft. is 11-gage slip-joint; 127 ft. is 12-gage slip-joint; 332 ft. is 10-gage flanged-joint; 323 ft. is 7-gage flanged-joint; and 144 ft. is ¼-in. flanged-joint. Air valves are set at two summits, both of which, however, are below the hydraulic gradient of the normal operating conditions. The bottom is anchored by a concrete footing. A taper nipple 10 ft. long reduces to 10 in. and connects to a Y, one branch of which supplies water for the generating unit, connecting to a rising-spindle gate valve inside the power house.

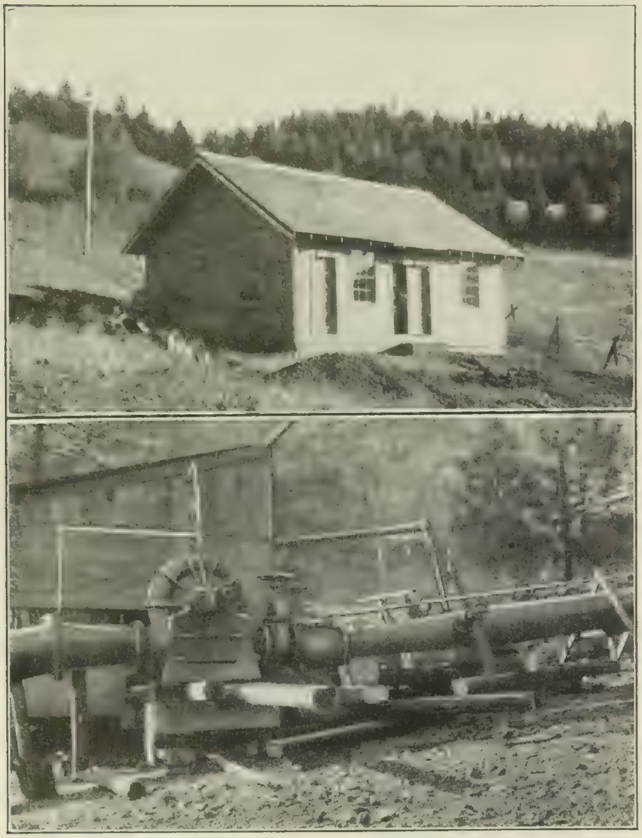


FIG. 2. POWER HOUSE AND PUMPING PLANT, WAHA SIPHON

The power house is a frame building 30 x 40 ft. Its floor is at El. 2934. It houses a single generating unit consisting of a 200-kv.-a. three-phase 2300-volt generator, direct-connected to a Pelton-Doble tangential wheel, developing a maximum of 400 hp. The static head is 590 ft. The water requirements of the waterwheel are much less than the 10 sec.-ft. supplied by the pump.

A bypass valve is connected on the second branch of the terminal Y. The waterwheel has a hand-operated needle nozzle; speed control is obtained by a stream-deflector actuated by a self-contained oil-pressure governor. A tailrace, excavated from the soil and unlined, conducts the water from the generating unit, and from the bypass, to a branch of Sweetwater Creek about 200 yd. from the power house. No water-measuring devices are installed in the tailrace. Several attempts have been made to use timber weirs, but the soil is extremely permeable, and these were quickly undercut and carried away.

A belted exciter is driven from the mainshaft of the unit. As the generator develops the full-line voltage, the electrical equipment is simple, consisting of a single automatic oil circuit-breaker, a voltmeter and an ammeter, and exciter and field control mounted on a single-panel switchboard.

The siphon is started, after priming pump and pipes with the gas-engine units as already noted. First, the waterwheel and generator are started; the pump attendant then throws the pump motor on the line as soon as he is notified by telephone. The 25,000-gal. reservoir at the summit will run the generator unit for about 20 min., driving the pump.

This siphon, as well as the entire system of the Lewiston-Sweetwater company, was developed by H. L. Powers, President and General Manager. The data for these paragraphs were obtained from Mr. Powers and R. H. Mann, engineer of the company, by the writer while inspecting the installation for the Pelton Water Wheel Co., contractor for the waterwheel equipment.

Index of Details for a Structural Engineer's Office

By Albert M. Wolf*

Well executed and consistent plans are the prime indication of a good design in all classes of structures; especially in building work, which involves a great many different types for the great variety of uses. This makes standardization of details and design somewhat more difficult than for the superstructures of highway and railroad bridges, but unless standardization is kept in mind constantly, the cost of making the design is quite likely to be so high as to show little profit; and at the same time the resulting structure may be more costly to the owner than if the reverse were true.

A large structural-engineering office—one employing a large force of draftsmen and designers, and carrying on work simultaneously on several large buildings—must of necessity have a good set of office standards for the guidance of the men and as an aid to the chief draftsman or engineer in obtaining uniform practice on all jobs of the same type, without necessitating his spending the greater part of his time giving instructions and personal supervision to each and every man or squad.

The office standards for concrete building design should include tables and diagrams for the design of reinforced-concrete slabs and beams (such as values of $K = \frac{M}{bd^2}$) for various combinations of unit stresses; areas and weights of steel bars; data on web reinforcement of beams; reinforcement of spandrel girders; diagrams and tables for the design and detail of reinforced-concrete columns and footings and for steel columns incased in

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concrete; tables and details showing amount and method of reinforcing concrete stairs, and standard sheets showing the arrangement of lettering, dimensions, details, etc., on the floor plans. For steel building design the standards may include properties of various types of columns; connection details; bracket details; cast-iron bases; typical details of spandrel beams, crane girders, steel stairs, steel stacks, tank floors, towers, etc.

In order that original and special details developed—which would not ordinarily be indexed in the general job file or included in the standards—may be readily found, a card index of various details of completed designs in the office files, which are likely to be used on other work or referred to at various times, should be maintained. With such a file a new man in the organization can at once acquaint himself with methods of detailing certain portions of a standard or special building without a lengthy explanation on the part of the chief draftsman, thus saving much valuable time and increasing materially the speed with which the plans can be completed.

Sheet Pile Cutoff Wall Allows Work Close to Cofferdam

By Charles F. Nimmo*

A box cofferdam 20 ft. wide was built on the lower side of the pass of dam 33, Ohio River, at Maysville, Ky. It extends 18 ft. above low water and is backed on both sides by river-run sand and gravel. The bottom of the pass is 1 ft. below, while the bottom of the crib (see sketch) is approximately 10 ft. below, the original river bed; so that if the construction work were brought too close, the outer arm of the cofferdam would be weakened. Especially would this occur when the river is at medium to high stage. In order to get the fastest progress under such a condition of high water, the cofferdam was safeguarded by the following device:

A line of steel sheet piles was driven around the outer end of the pass, as shown in Fig. 1. The crib for pro-

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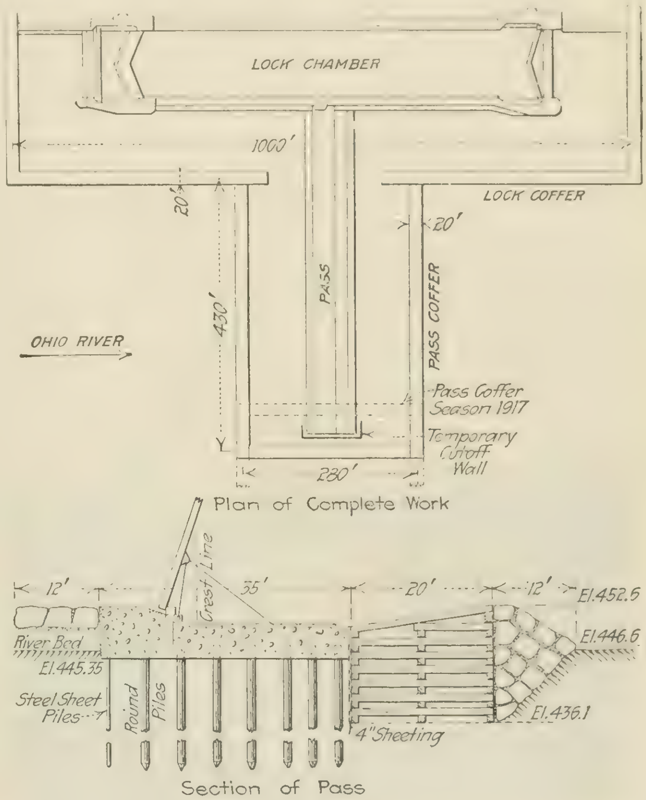


FIG. 1. LAYOUT OF WORK AT DAM 33, OHIO RIVER

FIG. 2. EXCAVATING CRIB INSIDE LINE OF SHEET PILES

tecting the concrete pass was assembled on the line and lowered to place by clamshells on traveling derricks, excavating within the crib. Piles were driven under the pass, forms were set, and the concrete was poured.

This cutoff wall enabled the contractor to complete an additional 52 lin.ft. of pass and 76 lin.ft. of crib with very slight increase in cost, as the piling is suitable for next season's work. The cofferdam area thus protected from flood was 160,000 sq.ft. The lock and dam are being built by the Bates & Rogers Construction Co. for the United States Government. F. M. Morgan is Junior Engineer for the Government.

FINE AGGREGATE

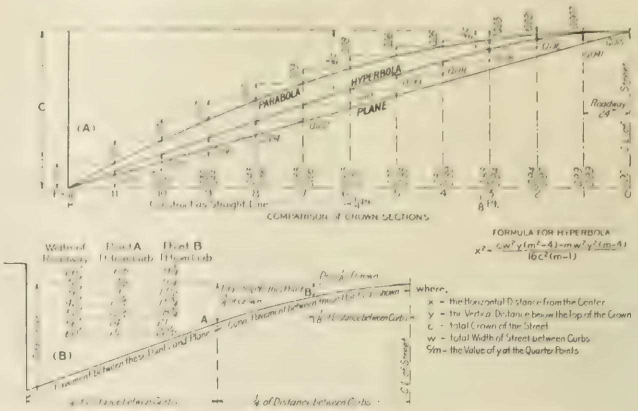
Heavy Truck Breaks Through Old Bridge—With the adjoining picture, a correspondent sends the following brief account of facts: "A 5-ton truck loaded with cement to capacity started across a bridge over an abandoned canal, the bed of which is now dry. The floor timbers of the bridge broke, and the truck fell to the bed of the canal. This was a paving contractor's truck." The accident occurred at Cohoes, N. Y., last summer. It illustrates the importance of the warnings

BRIDGE FLOOR FAILED TO HOLD UP LOADED CEMENT TRUCK

repeatedly given in the columns of "Engineering News" that the heavy loads of motor trucks are a menace to all but the most amply designed highway bridges. Poor maintenance, especially of timber parts, is a factor in increasing the danger of excessive loads.

Hyperbolic Curve for Pavement Cross-Section—The 40-ft. concrete pavements constructed in 1916 at Depew, N. Y., were given a cross-section whose middle half is hyperbolic, while the outer quarters are straight lines tangent to the hyperbola. The illustration shows the elements of this cross-section and its comparison with a cross-section made up of straight slopes intersecting at a central ridge, and with a parabolic cross-section of the same crown. For roadways with no car tracks a hyperbolic cross-section was used in which m = 8/3; that is, ⅜ of the total crown is the drop at the ¼ points. The equation of this hyperbola was reduced to a form for determining the vertical drop at any $\frac{1}{24}$ point of the roadway width.

On streets with car tracks, where the distance from the rail to the gutter is 12 ft. or less, block pavements are laid on a plane surface with a uniform fall from track to curb varying from less than ¼ to nearly ¾ in. to the foot, according to the kind of pavement used and the grade of the street. On other streets, where the distance is between 12 and 22 ft., the plane



HYPERBOLIC CURVE FOR PAVEMENT CROSS-SECTION

is varied slightly by using 7/3 for the value of m in the formula, deducting of course the space occupied by the rails from the width between curbs for w. The formula gives then a drop of practically ⅓ of the crown at the ⅛ point and $^{3}/_{7}$ at the ¼ point. For greater widths of pavement on car-line streets the regular ⅜ quarter-point formula should be used.

In chart A in the accompanying figure the portion of the total crown in each $\frac{1}{12}$ unit of the distance from the gutter to the center of the roadway is shown by figures along each of the curbs, and the total accumulated proportion of the total crown rise above the gutter for each cross-section by twelfths along the base line. It will be noticed that on the hyperbolic cross-section the rise from the gutter to the point half-way to the center is almost exactly a straight line, the variation at the extreme end being less than 1% of the total crown. In practice this portion of the pavement would therefore be constructed as a straight line. From the ¼ point to the ⅛ point the rise is almost exactly two-eighths of the crown, the remaining one-eighth being distributed in the center eighth section.—Charles A. Alderman, Buffalo, N. Y.

Cordwood Grillages are under the footings of a number of old buildings in lower New York City An excellent example of this type of bearing or grillage was uncovered during excavation for the new Bowling Green exchange of the New York Telephone Co., at Broad and Pearl Sts. These mats of saplings were found just below water line and probably date prior to 1800. On the mat, 3-in. planks 4 or 5 ft. long were laid at right angles to the axis of the wall, and on these two 12 x 12 stringers were placed, to support the masonry footings.

CORDWOOD GRILLAGE BUILT ABOUT 1780

Editorials

George Henry Frost

This number of *Engineering News* would be incomplete without a word in this place of personal regard for the man who founded this journal and who has passed from this life within the past week. On another page is told the story of Mr. Frost's life. We wish to emphasize here the great ambition which dominated him to render a large service to the civil engineering profession.

Forty-two years ago, when he was a struggling young land surveyor in Chicago, he dared to risk his slender means in starting a journal which should give to engineers the sort of information of which he himself had often felt the need. It was a long, hard, uphill struggle for many years; but what encouraged Mr. Frost to persevere was the appreciation and friendship of those who at that day stood in the forefront of the engineering profession. As the years passed on and he relinquished active work in the direction of his journal to others, he continued nevertheless his interest in the men of his profession. It was always a source of great pleasure to him to meet or to hear from some of the oldtime subscribers who had been helped by the work done in those early years. It was his greatest pride in later years to realize that his journal had become a powerful means of serving the engineering profession.

Mr. Frost was a good citizen, interested in and willing to aid in public affairs, a man of blameless honor and integrity, of genial personality, with broad human sympathies and a high appreciation of the best things in life. We whose privilege it was to be associated with him in the work upon this journal believe that we are speaking for a great body of engineers, those of the present day as well as those who have gone before, in paying tribute to his memory.

THE EDITORS.

Water and Sewer Facilities for All

Every city and town of any size now has a public water-supply, and most have at least a start toward a public sewerage system. Notwithstanding this, a large percentage of the families in these cities have no running water in their houses, no bathtubs and water closets or, having the two last named, lack sewer connections and are dependent on cesspools for waste disposal. Where live boards of health exist, they bring constant pressure to compel the abandonment of privies, cesspools and polluted wells and are as constantly resisted by property owners who declare their financial inability to make water and sewer connections and install modern plumbing.

In thousands of cases the plea of financial inability is well founded; and in other thousands of instances, although there may not be an absolute financial bar, the cost of needed house sanitary improvements would be a trying addition to existing financial overburdens. And yet public health and general welfare demand that these improvements be made.

How to meet this demand without undue resistance and burden is a question that has been discussed by boards of health and other local authorities again and again. That it has not often come before the health and engineering society conventions is perhaps surprising and gives all the more interest to a recent suggestive paper by R. A. Butler and F. C. Jordan, abstracted elsewhere in this issue. Their proposal is the annual-payment plan of meeting the first cost of water and sewer connections and plumbing fixtures, such as been followed with marked success by the gas companies for years past. Combined with this, the authors suggest a funding company in each city to finance the proposition, similar to the funding companies that have been such a factor in the automobile sales industry.

The proposed plan, which is presented with some illustrative detail, deserves thoughtful consideration. Alongside with it there should also be considered the alternative of having the city rather than a funding company finance the scheme. Those who have had to deal with the municipal side of abolishing privies, cesspools and polluted wells know that the people resent any action that savors to them of playing into the hands of a water company or plumbing concern or loan house. Certainly, the ideal would be for the city to give the poor man, for whom the authors of the paper are pleading, the benefit of the low prices at which the city can purchase material and the low interest notes at which it can borrow money. Obstacles to the attainment of this ideal are municipal inefficiency and the objections of local plumbers and contractors. It should be left to each community to choose between private enterprise and profit and municipal financing and control of some such general plan as that proposed to make modern house sanitation available to the poor.

San Francisco Water-Rate War

Water rates at San Francisco have been a bone of contention for so long that city officials, the Spring Valley Water Co., the citizens and above all the daily press would feel that something had dropped out of their lives if the controversy were to end suddenly. There is little immediate likelihood of such a happening, for although the rates for each of the seven years ending with 1914-15 are now out of the trial court and in the hands of a referee, the present and future rates, at least for water used through meters, are before the State Railroad Commission.

To add spice to the present rate case, account books and memoranda covering a number of the early years of the company are said to have come to light through the agency of the San Francisco *Chronicle*. These books, the *Chronicle* says, the company ordered burned, and supposed they were burned. It is alleged that the recovered books and memoranda will show that the Supervisors were justified in establishing such rates as they did for the seven disputed years, and will also show that

the meter rate of 28¾c. per 100 cu.ft. which the company has recently been trying to collect is altogether too high.

The folly of the old system of annual rate making by the Board of Supervisors (City Council) is emphasized by the litigation over the 1908-9 to 1914-15 rates which has impounded alleged excessive rates of $2,063,000 during that period, which has been banked at 2% interest, compounded monthly. The interest charges now amount to $215,000.

Those who argue for local rather than state control over utility rates may well heed the experience of San Francisco, although it would be unfair to debit all the controversy at San Francisco to local control. In the earlier years, at least, it was not real public control of rates that gave rise to much of the controversy. In fact, it is alleged that the control was quite the other way; that the water company and other utilities controlled the city authorities—to the personal profit of the latter and the expense of utility patrons and taxpayers.

Unprecedented Shipbuilding Conditions

No industry in the United States is working under greater pressure than the shipbuilding industry. For more than a year past, the constantly increasing demand for vessels to carry ocean freight, and the scarcity of vessels to meet the demand has brought greater and greater pressure upon every shipbuilding yard in the United States.

Now comes in addition to the economic pressure the realization that the most effective thing for national defense that the United States can do at the present time is to build vessels as rapidly as possible to keep up the movement of goods to Europe.

It is pretty well known that one main reason why Great Britain has so long held the lead of all other nations in the shipbuilding business is that she has been able to build freight steamers of standard types by the dozen instead of singly, and thereby greatly reduce the cost.

In the present emergency in this country it is generally recognized that the best plan for quickly producing a large fleet of merchant vessels is to build ships of the simplest possible construction according to standard plans, made with a view to utilizing available machinery and materials. This plan has already been put into practical execution. The hull of the modern freight steamer is practically a rectangular steel box except at the bow and stern. Probably more than nine-tenths of the work on such a vessel can be done with the methods and machinery of the ordinary bridge shop. Accordingly, one of the largest bridge manufacturing concerns in the United States has for some time been actively engaged in the construction of hulls for ocean vessels. It builds the entire hull with its ordinary force of employees and machines, with the exception of the bow and stern, which are left for completion by a regular shipyard.

The scarcity and high price of steel ship plates, which are now quoted as high as $150 per ton for 1918 delivery, has brought about an astonishing revival of wooden shipbuilding. In the Puget Sound district, that paradise of cheap and excellent lumber, the activity in wooden shipbuilding is limited only by the men available for the work. There are 68 wooden vessels now building in Pacific Coast yards with a combined capacity of 88,563 tons. Across the border in Canada work is equally active; 25 vessels are being built at Vancouver. To facilitate similar work on the Atlantic Coast, the Grand Trunk Pacific is hauling lumber clear across the continent on a passenger schedule. In Yarmouth, Nova Scotia, 35 wooden vessels are building.

The Federal Shipping Board has recently undertaken an extensive campaign to secure the building at every shipyard which can be made available where timber and labor can be secured, of standard wooden vessels with about 3600 tons capacity. It is far easier to obtain carpenters and timber to produce such ships than it is to get the material and skilled labor necessary for steel vessels.

With this situation in the shipbuilding industry it is doubtful how the craft are to be produced to carry on business in the New York barge canal when that is opened a year or so hence. The old Erie canal boats have nearly all disappeared; not more than a couple of hundred are now left, it is estimated. For economical freight handling on the new waterway, vessels will be required of 2000 to 3000 tons' capacity with a beam up to 45 ft. and a draft of not over 11 ft. Such boats will only be suitable for use on protected waters. Where are the men to be found who will invest money in boats of this type to ply on the barge canal in competition with the rail lines when vastly larger returns are promised by building vessels capable of ocean service?

Engineering Ethics Collated

The ethical considerations underlying or governing the profession of engineering did not assume much importance in the early days. Doubtless the practitioners then were honest and honorable and had certain unformulated moral rules by which they conducted their business, but the definite desire for a Code of Ethics came only as the trade of engineering began to approach a profession in nature. In fact such a desire marks the beginning of the professional spirit.

That such a spirit is strong and healthy today is obvious to the most casual student of engineering progress, but possibly a recent bibliography compiled by the Carnegie Library of Pittsburgh will serve to emphasize the fact. This pamphlet, just issued, is called "Engineering Ethics" and contains 152 references to as many articles in technical and society periodicals on that engrossing subject. To the many individuals and societies now studying the human side of engineering as distinct from the purely technical, this list should be of great service. Thanks are due the library for its recognition of a professional need.

Fixed Dams To Replace Movable Dams on the Upper Ohio

It is nearly 42 years ago that Congress first authorized the improvement for navigation of the Ohio River. The plan then contemplated the eventual construction of a series of movable dams from Pittsburgh to Cairo, dividing the river at low water into a succession of pools. At flood stages, however, the dams were to be lowered and boats were to use the open river as they did before the improvement.

The first of the movable dams, that at Davis Island, 5½ miles below Pittsburgh, was completed in 1885, ten years after the original appropriation in the River and

Harbor bill of 1875. The dam was at that day considered a great achievement in engineering construction. It was, however, not strictly novel, but merely a copy on a larger scale of what engineers on the continent of Europe had for some time been doing in improving smaller rivers for navigation.

Ever since its completion, the Davis Island dam has served chiefly to create a navigable pool at all seasons of the year in the Allegheny and Monongahela Rivers at Pittsburgh. Congress for many years took only a languid interest in it as the first step in a chain of works that should create slack-water navigation in the Ohio all the way to Cairo. Additional appropriations for locks and dams were made in 1890, 1896, 1899, 1902 and 1905, and two more locks and dams were finally completed in 1904 and 1906, 30 years after Congress made the first appropriations for the work.

A general awakening to the absurd wastefulness of this method of conducting river and harbor work occurred during the Roosevelt and Taft administrations. It came to be realized that the old dilatory methods had saddled the Government with certain works which became obsolete before they were completed, like the Hennepin Canal. It was evident, also, that the slack-water navigation works on inland rivers had in most cases developed no traffic proportionate to the amount expended on the work.

The advocates of waterway improvements claimed, however, that the Ohio was a stream which was big enough and had traffic enough to justify improvement, and that if money were concentrated on the Ohio River work and the depth were increased to 9 ft., instead of the 6 ft. contemplated when the original improvement was planned, a sufficient volume of boat traffic would develop to justify the great investment necessary.

In line with these ideas, Congress in 1910 adopted a project for completing the improvement of the Ohio River in 12 years by the construction of 54 locks and movable dams at a total estimated cost of about $64,000,000, in addition to prior appropriations.

The last annual report shows that in the past seven years about $22,500,000 of that amount has been expended; 16 dams are completed; 18 are under construction, and on 19 others work has not yet been begun. One dam, No. 42, has been eliminated. While the law specified completion within 12 years, Congress has interpreted this to mean supplying the funds in that time, or practically at the rate of $5,000,000 a year, a rate which has been substantially maintained up to the present year. There still remains about $33,000,000 to appropriate to complete the work. Judging by the present and impending condition of the national treasury, it is doubtful whether funds will be forthcoming hereafter to carry out the work at the rate planned.

It is not at all strange that work begun so long ago and so leisurely carried on should in some parts become obsolete before its completion. It is now proposed, and we understand practically decided on, to rebuild one or more of the first six dams below Pittsburgh as fixed dams instead of movable dams. The reasons for this are numerous. Dams Nos. 1 and 2 are in poor condition. The former, now 32 years old, requires constant and extensive repairs and must soon be rebuilt anyway. These dams were originally built for a 6-ft. navigation instead of a 9-ft., and the changes made leave them structurally weaker than the standard type.

A more significant reason, however, is the traffic change which has taken place in the Ohio River. One controlling reason for the original adoption of movable dams for the Ohio River work was the importance of the down-stream coal traffic in large tows when the river was in flood. The coal hoisted from mines along the Monongahela River was delivered into cheap wooden barges and held there until the river rose to a "coal-boat" stage. Then fleets of these barges, often acres in extent, would start down the river steered by a big stern-wheel towboat, and much of it would finally land at New Orleans, where the coal was sold and the barges were broken up for lumber.

This water transportation represented a phenomenally low ton-mile cost; but it was based on conditions which were not permanent. The forests from which came the cheap lumber that built the coal barges have been cut off. It would not pay to tow the empty barges back to up-river points. More important still, the Pittsburgh Coal Co., which controls the bulk of the mines in the Pittsburgh district from which river shipments have been made, has decided that all the remaining coal in the Pittsburgh district will be required for local industries, and hence no more should be sent to distant markets. There are to be no more huge fleets of coal barges started down stream from Pittsburgh when high water comes; hence one of the arguments which 40 years ago caused the adoption of movable dams for the upper Ohio has disappeared. Coal tows are still to be sent down the river, but they will go to the Ohio from some of the rivers which tap the West Virginia coal fields.

The question—and it is a very broad one—is thus raised whether movable dams or fixed dams should be adopted in works for navigation improvement. The United States Engineers have now accumulated a good many years experience in the operation of movable dams. It is realized now, better than in the past, that movable dams of all types are expensive to construct, expensive to maintain and subject to certain risks of accident in operation. Local conditions as to the obstruction of a flood channel by a fixed dam and consequent heavy land damages may make the use of a movable dam necessary at a given point; but the use of movable dams over the whole length of a large river merely to facilitate down-stream navigation during flood season will probably be more critically studied hereafter before adoption.

Besides these questions of engineering practice, the history of the Ohio River improvement is an illustration of the wasteful policy that so long prevailed in waterway legislation of undertaking work without making adequate provision for its vigorous prosecution. There has been a notable change in this respect in the last decade, but there is still need for further improvement. If the Ohio River improvement was worth while 40 years ago, the work ought to have been undertaken then and completed as fast as men and money could do it.

If a private corporation undertakes an enterprise the work is pushed to completion with all possible speed, for interest charges begin to accumulate as soon as the work is started, and it is a race to see whether the profit-earning stage can be reached before the load of interest charges becomes sufficient to swamp the business. Many of those who figure out the profit which Government enterprises yield wholly omit any charge for interest on the money invested during construction.

Letters to the Editor

Responsibility of New Pavement Construction in Cleveland

Sir—I beg leave to comment upon the article in "Engineering News," Feb. 17, 1917, headed "Cleveland Engineering Society Urges Commission for City Paving." The inference from reading that article would be that the City of Cleveland possesses no organization to properly design and supervise street paving, as the article states that the supervision of the paving must necessarily be referred to the Street Department, now organized only to care for maintenance work.

As a matter of fact, Cleveland has always had an Engineering Department, under the direction of which the construction and reconstruction of all pavements have been placed. Under the general direction of the writer alone there has been laid some 200 miles of paving at an expenditure of from $7,000,000 to $8,000,000.

In connection with the proposed program of repaving, made possible by reason of the $3,000,000 bond issue to pay for the city's share of paving work, it has been planned, with the exception of a limited amount of resurfacing work, to have the entire amount of such work under the direction of the Engineering Department, as has been the custom in the past.

The suggestion to appoint a commission to assume general direction of paving work is still pending; but in the absence of city-charter changes, which would be necessary to establish a commission of this kind, it is obvious that the mayor cannot shift the responsibility, which he has by virtue of his office, to see that the work is prosecuted in accordance with the method and by the organization now prescribed.

Exception is taken to the statement that "the experience of many cities has demonstrated that the latter plan (special commission) is far more likely to produce honest and economical work." So far as the writer knows, comparatively few cities have appointed commissions to assume direction of paving work, where a proper organization had already been provided through an engineering department.

It is the judgment of the writer that the article might give rise to inferences that neither the sentiment of the Cleveland Engineering Society nor Cleveland's public opinion would justify.

ROBERT HOFFMAN,
Commissioner and Chief Engineer.

Cleveland, Ohio, Feb. 24, 1917.

The Art of the Dishonest Expert

Sir—The recent contributed articles in "Engineering News" on the subject "The Art of the Expert Witness" were an excellent presentation of a subject which has heretofore received scant attention in the engineering press. It seems to me however that the subject of dishonest testimony by "expert" witnesses has not even yet received the attention which its prevalence demands, and that the dishonest "expert" has been allowed to escape with but a very mild condemnation.

The article in question accounts for a difference of opinion among experts in valuation cases, largely upon the ground of a difference in hypothesis. A difference in hypothesis might be accepted as one of the incidents of independent thought if the hypothesis were plainly set forth, but it is the part of the dishonest "expert" to conceal, and if necessary to deny, his fantastic hypothesis. When it is disclosed upon cross-examination that an estimated value of a water power, for instance, is based upon the utilization of the total unregulated flow of the stream, upon a 100% load factor and upon the sale of the power in a territory already well supplied, then the dishonest "expert" witness cannot escape the judgment of his more honorable associates by pleading a difference in hypothesis. Yet this sort of evidence has become so common that the name "expert witness" has become almost a term of reproach.

The testimony of witnesses is supposed to be for the purpose of enlightening the court upon the facts, so that a just decision may be rendered. If a wholly theoretical hypothesis, having little or no practical application is assumed, the court is confused instead of enlightened, and all expert testimony is to an extent discredited. In a recent book, "Recollections of an Alienist," by Dr. Allan McLane Hamilton, the celebrated authority on brain diseases, a chapter is devoted to the subject of expert testimony; there referring to the prevalence of dishonest expert testimony, Dr. Hamilton says: "The execration of expert testimony by the courts, press and public, is an instance of visiting the sins of the many upon the few—thus reversing the ordinary run of this well-worn saying."

During the last five years there have been tried before the Court of Claims of New York State, water-power damage cases arising from the construction of the new Barge Canal, in which the aggregate damages claimed have no doubt surpassed those ever demanded of any state in the Union as the result of a single project. The trials of these water power cases have called for a large amount of engineering work in their preparation, and have brought forth a mass of "expert" testimony which is a disgrace to the engineering profession. The valuations of water powers by the experts on the two sides in these cases have varied in the ratio of 1 to 10 in many instances, and in the majority of the cases have been so far apart as to create in the nontechnical mind a belief in the utter unreliability of expert testimony. The excuse of difference in hypothesis seems somewhat absurd in cases of such wide variation.

The dishonest "expert" cannot escape just criticism upon the ground that he acts under the direction of the attorney for his clients, for he may resign from the case at the first demand for misleading or dishonest testimony.

It seems to the writer that the only way in which the court may be reasonably sure of securing disinterested and honest technical service is to make the expert witness an appointee of the court, for in that case the expert witness will be as free as the court to render service solely in the interest of justice. The employment of technical assistance by the court need not prevent the employment of expert witnesses by the litigants, but the presence in the case of a competent and disinterested expert would go far to prevent the introduction of dishonest testimony or the use of hypotheses wholly theoretical and without practical application. This plan in effect, has been in operation for several years in the public service commissions of several of the states, where the engineer of the commission takes a part in important cases, assists in clearing up disputed points and is himself subject to cross-examination by either side.

The engineering profession will not be benefited by the assumption that the abuses complained of do not exist. They are already well known to all who have had a part in the trial of cases involving expert testimony, and to a considerable degree by the public at large. The great engineering societies might well devote some thought to a solution of the problem, and the individual engineer should resist every influence tending to restrict his judgment or to force him to work upon a false hypothesis.

H. B. SWEET,
Consulting Engineer.

Utica, N. Y., Mar. 17, 1917.

More Information on Durax Road Pavement

Sir—In the article entitled "New Jersey Introduces Small Granite Cubes for State Road Paving," in "Engineering News," Mar. 15, 1917, p. 429, a few errors have crept in. In the next to the last paragraph you say: "One portion of the work was not grouted until freezing weather came on; and in order to complete the work, a bituminous mastic was used in place of the portland-cement grout, with apparently as satisfactory results as in the first method." While in my judgment the mastic is equal to the grout as a filler, and has been used on several other jobs, yet no change was made on Morris turnpike.

The costs should be 90c. per sq.yd. for the concrete base and $2.58 a sq.yd. for the Durax paving. The Bamberger & Chapman Co., and not the undersigned, was the contractor, under F. A. Reimer, County Engineer of Essex County, and the Durax blocks were furnished by the Harris Granite Quarries Co., of Salisbury, N. C., through the undersigned.

C. E. McDOWELL.

45 Clinton St., Newark, N. J., Mar. 16, 1917.

Death of George H. Frost, Founder of Engineering News

George Henry Frost, who was the founder and, until 1911, the publisher and chief owner of *Engineering News*, died at his residence in Plainfield, N. J., on Mar. 15 after an illness of several weeks. Although in his 79th year, Mr. Frost had been in good health until a few months ago, when gradual failure of the circulatory system became evident.

Mr. Frost was a Canadian by birth, but his parents were natives of Vermont, who emigrated to St. Lawrence County, New York, and later removed to Canada. Mr. Frost's father established a general foundry business in Smiths Falls, Ontario, which after many years of pioneer hardship was developed by older brothers of Mr. Frost until it became the second largest agricultural implement works in Canada. The early education of George H. Frost was obtained at village schools and later at an academy in Glover, Vt. In the years from 1858 to 1860, he studied civil engineering at McGill University, Montreal. Here he received an excellent training in mathematics and in natural history, taking the latter subject under Principal Dawson, afterward Sir William Dawson. His instruction in civil engineering, however, Mr. Frost described as simply farcical. The modern civil engineering course at McGill was established many years later. At the time of his death Mr. Frost was the oldest living engineer graduate of McGill. According to the custom of that time, Mr. Frost was apprenticed after his graduation to a provincial land surveyor, and after two and a half years' work received a diploma and the right to use the letters P. L. S. after his name and follow the business of a land surveyor. For a few months he attempted to earn a living by surveying land for farmers in the vicinity of his father's home at Smiths Falls, but he soon became disgusted with the dull life and small earnings.

He had originally taken up civil engineering because it promised a life of roving adventure. In August, 1863, he started on a trip to New York City, but changed his mind on the way and landed in Chicago. He secured employment as a rodman in a railway surveying party which was laying out the line of what is now the Chicago Northwestern R.R., from Madison, Wis., to Winona, Minn. When the season's work closed, Mr. Frost was retained for a year in the office of the engineer, and later for two years in the land commissioner's office.

Geo. H. Frost

He then opened an office for himself as a city surveyor. At that time (1867) there were only two or three civil engineering offices in Chicago. About the only profitable work for civil engineers in that locality was simple land surveying, laying out new subdivisions for the rapidly growing city. For a half a dozen years times were prosperous, but in 1873 came the panic and the collapse of a real estate boom, and the land surveying business was at a low ebb.

It was at this time of financial stress that Mr. Frost ventured on a project he had long been considering—the founding of a journal devoted to civil engineering. A more unfavorable time to launch such an enterprise could hardly have been imagined, but Mr. Frost was of an ultrasanguine temperament, and notwithstanding his almost total lack of means he determined to try the experiment. The first number of the *Engineer and Surveyor,* as the journal was called, was issued on Apr. 13, 1874. The matter for the first number Mr. Frost prepared himself in spare time in the evening after his day's work as a surveyor was finished. A relative who was in the printing business attended to the mechanical production of the sheet, and W. F. Goodhue, a civil engineer who was later city engineer of Racine, Wis., attended to the distribution of the printed copies. The journal met a favorable reception and had a bona fide subscription list from the start. It had, however, practically no advertising patronage, and the white paper it was printed on cost in those days 15c. per pound. There was consequently a monthly deficit which Mr. Frost had to make up from his earnings as a land surveyor, eked out by occasional loans. Nearly twenty years ago, Mr. Frost prepared, at the request of the editors, some very interesting reminiscences of these early days in the development of *Engineering News.* In the first issue of the *Engineering News-Record,* to be published on Apr. 5, there will be presented a history of *Engineering News,* prepared largely on the basis of these reminiscences.

From the first, Mr. Frost found it necessary to enlist the aid of others in the editorial conduct of the journal, and the limitation of means and opportunity made editorial changes frequent. In 1878 Mr. Frost removed to New York City, and the journal was thenceforth published there, the offices being located in the Tribune Building for 17 years, and later in the St. Paul Building.

During most of the journal's first decade, the financial returns were meager. In 1883, the late D. McN. Stauffer

joined Mr. Frost in the enterprise, purchasing a part interest in the journal, and assuming editorial direction. Four years later the late Arthur M. Wellington purchased a part interest in the journal, and joined Mr. Stauffer in the editorial work. The years that followed were years of very rapid growth and prosperity. Eventually, Mr. Frost repurchased the interest which had been sold to these and other business associates, and he was the sole owner in 1911, when he finally disposed of the journal to the Hill Publishing Co.

In 1886, Mr. Frost became a resident of Plainfield, N. J., and took an active interest in the public affairs of the city. He served for five years as a member of the City Council, and in the early '90's had the chief responsibility in the establishment of a sewerage system. He purchased the principal paper of Plainfield, the *News-Courier*, many years ago but left the management to his oldest son. He was a member of the Presbyterian Church in Plainfield and took an active interest in its affairs. He was a member of the Canadian Society of Civil Engineers, an Associate of the American Society of Civil Engineers, and was given honorary membership in a number of other engineering societies. He is survived by his widow and four sons.

Relative Advantages of Brick or Concrete Sewers for Chicago

The relative cost and serviceability of concrete and brick for sewers has been reported upon by the staff of the Chicago Council Committee on Finance, with reference to an ordinance sent to the council by the Board of Local Improvements and providing for a concrete sewer in Kedzie Ave. (south of 71st St.). The report showed no material advantage or disadvantage for concrete as compared with brick, except that the cost for the former probably would be somewhat less. The council committee, however, recommended the use of brick, which is the general practice in Chicago.

The report is based upon local experience and upon inquiry made in a number of cities using concrete for sewers. In Chicago, the trunk and outfall sewers are of brick, with a few exceptions. There are also plain and reinforced-concrete sewers, and the South Chicago district has a system of 2½- to 10½-ft. sewers of plain concrete, built in 1908. The Sanitary District of Chicago permits the use of concrete, brick and segmental block. The element of cost (except in special cases) is the determining factor in selecting the material to be used for its large sewers.

Analysis of the returns for 32 cities using concrete for sewer construction show that 27 are using concrete now and 25 have used it for a number of years. It is not used exclusively by all of these cities. Most of the returns state that there is little or no deterioration or erosion of concrete, though in some cities having steep grades the concrete inverts are lined with vitrified brick to prevent erosion. The grades in Chicago are too light for trouble of this kind.

It is pointed out that under certain conditions the action of acids in or gases from sewage tends to disintegrate concrete masonry and the mortar joints in brick masonry, the extent of the injury in each case depending upon the condition of the sewage. The effect is more noticeable where poor materials and poor workmanship have been used. As Chicago uses the combined system of sewers, the average sewage is greatly diluted and decomposition is not pronounced. There are exceptions, where the sewage is made up largely of trade wastes.

As to cost, the general opinion in a number of cities is that concrete costs 10 to 15% less than brick, the saving being in cost of materials and labor, etc. The report states that advantage is sometimes taken of the effect of the smooth concrete surface in reducing the friction, thereby making it possible to use a smaller sewer of concrete than of brick to carry the same volume of sewage. This means a reduced volume and cost of masonry. As to adaptability, it is stated: "Concrete and brick are equally well adapted to most conditions met in sewer construction, although adherents of one or the other material claim advantages under particular conditions."

The report also quotes the Chief Engineer of the Sanitary District, as follows: "For Chicago conditions, concrete as a material for sewer construction is more suitable than brick, chiefly for the reasons that it is more economical and is fully as good, if not better, from the viewpoint of efficiency and durability."

The advantages of monolithic concrete, concrete pipe and brick for sewers are set forth substantially as stated below. Tile-block construction is not included in the investigation.

Monolithic concrete is lower in first cost; it may be molded to any form desired; and the thickness may be varied to suit requirements and local conditions. The natural earth under the sewer is not disturbed; and as the concrete fills all irregularities, a better foundation is obtained. With brick and reinforced-concrete pipe proper backfilling under the quarters is difficult to obtain. Reinforced-concrete sewers can be made to develop strength when subject to strains not predetermined. Concrete can be made impervious by proper proportioning, mixing and placing. A smoother surface is obtained in concrete through the elimination of all joints, with a resulting higher carrying capacity.

For reinforced-concrete pipe, the advantages are that in wet trenches it may be easily and quickly laid and that proper inspection may be more easily made.

For brick, the advantages are that Chicago contractors have reached a high degree of efficiency in brick-sewer construction. Also, under certain conditions, when the progress of work is intermittent on account of traffic or other reasons, or when the job is of limited extent, brick may prove to be more economical.

Conclusions of the report are as follows:

The first cost of a concrete sewer is 10 to 15% lower than for a brick sewer. This is based on the opinion of officials in other cities and on data comparable with Chicago conditions.

Brick and concrete under typical Chicago conditions are equal in durability for sewer construction. This is based on the experience of other cities in the use of concrete and on the experience with brick in Chicago.

Both brick and concrete are adaptable for sewer construction in Chicago.

Argument in the New York-Passaic Valley Sewage-Disposal Case has been set by the United States Supreme Court for Oct. 2, 1917. The suit is for an injunction to prevent the discharge of sewage into New York Harbor from the trunk sewer being built by the Passaic Valley Sewerage Commission from Paterson to Newark, then beneath Newark Bay, Bayonne, and New York Harbor to a multiple outlet near Robin's Reef Lighthouse. The United States was originally a party to the suit, but withdrew on stipulation with the Passaic Valley Sewage District for the treatment of the sewage so as to give an effluent of stated quality. It was supposed that New York City and New York State would also withdraw the suit, but this was not done. Much testimony by many experts has been taken on each side. The case has been pending altogether for years. It was expected that the trunk sewer and tunnel outlet would have been completed and in use before this time, but there has been much delay, owing, it appears, to tunneling difficulties.

News of the Engineering World

Interstate Commission Will Study the Port of New York

An interstate commission to study the improvement of railway and water transportation and terminal facilities for the entire port of New York, including the part in New Jersey as well as in New York State, is likely to be appointed through the joint action of Governor Whitman of New York and Governor Edge of New Jersey. It has become more and more apparent during the last decade that the economic development of the port of New York on lines necessary for its future growth and prosperity must be undertaken without regard to state boundaries.

Further than this, it is probable that the development should be carried out with the governing idea of rendering the greatest public service at minimum cost and with all idea of one transportation company taking advantage of another in a competitive way eliminated. Bills are pending in both legislatures to provide appropriations for such a joint commission. Since the movement has the support of both governors, it is probable that the appropriations will be granted.

Montana Legislature Authorizes Commission-Manager Plan

A well-considered commission-manager plan of government, applicable on approval by popular vote of the cities of Montana, is authorized by a bill that has recently passed the legislature of that state and has been approved by the governor. The legislative functions of cities adopting the new form of charter will be performed by three commissioners at large in cities of less than 25,000, and by five commissioners in those of 25,000 population or more. Each commissioner must own real estate in the city, assessed at a value of not less than $1000. The salary of each commissioner will be $5 for each meeting attended, with 50% additional for the commissioner who serves as mayor. The commissioners are subject to recall, but it is interesting and encouraging to note that a recall provision applying to the city manager was stricken out of the bill. The city manager will be appointed by the commission. He need not be a resident. He will hold office at the pleasure of the commission. His salary will be fixed by the commission, but will not be subject to decrease during his term of office.

The duties of the city manager will be to see that all laws and ordinances are enforced and to appoint all directors of departments and all subordinate employees in the departments, both for classified and unclassified service, the latter subject to civil service. The city manager will have power of removal also. He will formulate the budget for submission to the commission.

City affairs will be administered under five departments, each headed by a director, subject to the orders of the city manager. The five departments are service, welfare, safety and finance. The commission *may* appoint a Municipal Plan Board, and upon the request of the city manager it *shall* appoint advisory boards. The Civil Service Commission will consist of three electors appointed by the city commission or council. The act went into effect on its approval by the governor.

The director of public service is given authority "to compel the making of sewer, water, gas and other connections whenever, in view of contemplated street improvements or of sanitary regulation," such connections should in his judgment be made.

The director of public service is also made supervisor of plats, with authority to "require all streets and alleys to be of proper width, to be co-terminate with the adjoining streets and alleys." Plats made on his initiative or made by property owners on their initiative are subject to his approval. No other streets or alleys except those approved by the supervisor of plats or those "laid out by the municipality" shall be "accepted as public streets or alleys by the municipality." Another significant feature of the commission-manager charter act is this: "No plat subdividing lines within the corporate limit, or within three miles thereof, shall be entitled to record in the recorder's office of the county without the written approval of the director of public service indorsed thereon."

An Appeal for Assistance to British Engineers and Professional Workers

Few engineers in the United States probably realize the serious hardship which the civil engineers, architects and members of other professions in Great Britain have suffered since the outbreak of the war. The mechanical engineers, indeed, have had work in plenty; but engineers in most other lines have been almost wholly without employment. The following appeal to the engineers of America on behalf of the engineers and other professional workers of Great Britain has been issued over the signatures of eighty prominent American engineers.

To the Members of the Engineering Profession in the United States:

The families of many professional men in Great Britain are experiencing privation such as they have never before been called upon to face. This is true not only as regards families of those at the front, but also as regards families of many who are excused from active service because of age or physical disability, but who find themselves in need owing to the fact that they no longer are able to earn an income in the practice of their professions. For example, an architect in England today has practically no possibility of professional employment, except in governmental work, as the construction of buildings, except those required for Government purposes or specifically authorized by the Government, is not permitted.

To relieve the resulting hardships and distress, the Professional Classes War Relief Council, Inc., was organized in Great Britain shortly after the outbreak of the war. Maj. Leonard Darwin, a son of the great naturalist, is chairman of the Council. Jerrard Grant Allen is now in America representing the Council, and independent investigation has confirmed his statements in respect not only of the need which exists, but also in respect of the organization and methods of the War Relief Council.

The administrative expense, which is limited to compensation of subordinate employees, amounts to less than 2%, of the money distributed. The Council directs its activities largely along lines which provide relief by finding temporary employment for those whose accustomed way of earning a living is cut off, but in many cases pecuniary help is necessary.

The undersigned appeal to American engineers to demonstrate their sympathy by contributing to this most worthy object. Let us help in this crisis as we should hope our professional brethren in Great Britain would help us were their position and ours reversed.

Contributions may be forwarded to Lewis B. Stillwell, treasurer, care the Farmers Loan and Trust Co., 475 Fifth Ave., New York.

Alden, G. I., Worcester.
Arnold, Bion J., Chicago
Baekeland, Leo H., Yonkers.
Brackenridge, W. A., Los Angeles.
Buck, Harold W., New York.
Byllesby, H. M., Chicago.
Carty, John J., New York.
Crosby, Oliver, St. Paul.
Doherty, H. L., New York.
Dunn, Gano, New York.
Duryea, Edwin, Jr., San Francisco.
Emmet, W. L. R., Schenectady.
Galloway, John D., San Francisco.
Gibbs, George, New York.
Herr, E. M., Pittsburgh.
Herschel, Clemens, New York.
Hollis, Ira N., Worcester.
Humphreys, A. C., New York.
Hunt, Charles Warren, New York.
Insley, W. H., Indianapolis.
Insull, Samuel, Chicago.
Jackson, Dugald C., Boston.
Jennings, Hennen, Washington
Lincoln, Paul M., Pittsburgh.
McHenry, E. H., New Haven.
Mailloux, C. O., New York.
Mershon, Ralph D., New York.
Molitor, F. A., New York.
Parsons, William Barclay, New York.
Pegram, George H., New York.
Rand, Charles F., New York.
Rice, Calvin W., New York.
Rushmore, D. B., Schenectady.
Sanderson, E. N., New York.
Saunders, William L., New York.
Sprague, Frank J., New York.
Stillwell, Lewis B., New York.
Swain, George F., Cambridge.
Taylor, Stevenson, New York.
Thomas, C. C., Baltimore.
Townley, Calvert, New York.
White, J. G., New York.
Wilgus, W. J., New York.
Yarnall, D. Robert, Philadelphia.
Yeatman, Pope, New York.
Younger, John, Buffalo.
And thirty others.

Cleveland Street Paving Discussed

The street paving situation in Cleveland was the subject of the annual meeting of the Civic League of Cleveland on March 17. It was announced that the League will spend between \$7000 and \$8000 during the year on paving inspection and that about \$6000 is now in hand. The league will employ a competent paving engineer who will hire his inspectors. Daily reports will be made to the secretary of the League and weekly or monthly reports will be made by the League to the public. Primarily the effort is to recite facts to the public and to prevent the acceptance of paving which is in any way below specifications. It is the intention, also, in this recitation of facts to give praise where due.

C. S. Howe, president of the Case School of Applied Science, speaking on "The Need of a Comprehensive Plan of Paving," stated that the \$3,000,000 paving bond issue involved the expenditure on the part of the whole city of from \$6,000,000 to \$30,000,000, depending on whether the bond issue was used mostly to relay or to pave streets new. On new work the city's share is 10%, on relay 50%, according to present plans, the abutting owner paying the rest. It is the largest sum Cleveland has ever determined at one time to spend. Probably not more than a million a year will be spent so that the work authorized by the bond issue will extend over several administrations. He argued that a definite plan of procedure should be drawn up by a competent committee or board, and that the plan should be turned into law by the council so that succeeding administrations could not alter it; in other words, he would give it stability and freedom from politics. He argued for a competent paving engineer under the city engineer, and that the paving engineer should not change with the administrations as the city engineer may.

Alex. Bernstein, Director of Public Service, spoke on "The Administration's Plan and Point of View." He said that a survey of Cleveland pavements had been made in 1916 and a paving program mapped out by the Engineering Department. It was found that the most pressing need is the repaving of the main thoroughfares, 42 miles needing immediate repaving. He paid a high tribute to Robert Hoffmann as the best equipped man for mapping out such a program, he having been in the department 23 years. He also paid high tribute to Mr. Williams, Mr. Hoffmann's assistant in charge of paving. Mr. Bernstein said all inspectors were to be appointed from the civil service list.

Robert Hoffmann, speaking on "The Engineering Problems Involved," said that it is comparatively easy to find engineers expert in one line of pavement, but not in all. He noted that manufacturers employ engineers expert in their particular line of pavement and that the experience and knowledge of these men are available. Touching on the financial features, he said the city ought to look forward to the end of the life of the pavement and make proper provision for renewal. If the average life of a pavement is 25 years, then the program should provide for the renewal of over 20 miles annually, Cleveland having 570 miles of paved streets.

Hetch Hetchy Water-Supply Progress and Program, San Francisco

Considerable progress on its great water-supply scheme was made by San Francisco in 1916; and if recommendations made by M. M. O'Shaughnessy, city engineer, are carried out, much more will be done and some important contracts will be let this year.

During 1916 over 80% of the Hetch Hetchy R.R., which is 68 miles long, standard gage, was graded and 9 miles of track laid. This road extends from Hetch Hetchy Junction, on the Sierra Ry., to the site of the Hetch Hetchy dam and will be used for construction purposes. Progress was also made on a temporary power plant at Early Intake. This is known as the Lower Cherry power development and will supply power for construction purposes. At the Hetch Hetchy dam site a 20-ft. diversion tunnel, 457 ft. long, begun in 1915, was completed. A large area of the future reservoir has been cleared. Detailed surveys show that the total length of the aqueduct from the Oakdale portal in the Sierra foothills to the University Mound reservoir will be 118.66 miles or 2 miles more than was given in the Freeman preliminary report.

On Jan. 5, 1917, a contract for exploring the Hetch Hetchy dam site was let to the International Diamond Drill Contracting Co. for an estimated total of \$14,675. The borings must be completed within 120 days. The plans and specifications for the dam will be drawn as soon as these site borings are completed. It is hoped that a contract for the construction of the dam will be let during 1917.

Bids for constructing 19 miles of aqueduct tunnel from Early Intake to Priest regulating reservoir, near Moccasin Creek power house, will probably be invited this year. The estimated cost of this section is \$6,000,000. It is proposed to divide it into several four-contract units of

about 5 miles each, and that 4 or 5 years will be required for the work.

A bond issue of $11,000,000 was recommended by Mr. O'Shaughnessy some weeks ago, of which $10,000,000 would be for the Hetch Hetchy dam and 19 miles of aqueduct, and $500,000 for the temporary power development, each as already mentioned, and the remaining $500,000 for numerous minor purposes. The dam and aqueduct appropriation would be expended during a series of years, but the money must be provided before the contracts can be let.

Relation of State Boards of Health to Water-Supplies Discussed

Whether a State Board of Health should have compulsory or advisory powers was the most important subject of discussion at the annual meeting of the Illinois section of the American Water-Works Association, held at the University of Illinois on Mar. 13-14. The former view was taken by Paul Hansen, engineer of the Illinois State Board of Health, on the ground that it is necessary to have control over the actions of local authorities. S. A. Greeley (Winnetka) supported this view, pointing out that advice from the Board has failed to induce the local authorities of Winnetka to install a filtration plant, which is much needed on account of typhoid cases in towns further north. On the other hand, John W. Alvord (Chicago) considered that the main action of such boards should be on educational and advisory lines, and that their usefulness will be destroyed if they assume arbitrary control, as has been the experience in other states. W. A. Shaw, of the State Public Utilities Commission, suggested control of pollution of all navigable streams by the Federal Government.

Looking for a Nitrate-Plant Site

Hearings on the question of the location of the Government nitrate plant, for which $20,000,000 has been appropriated, were held at various Southern cities beginning March 8 by the interdepartmental board, consisting of the Secretaries of War, Interior and Agriculture. Accompanying them on their tour of investigation were Gen. W. M. Black, Chief of Engineers, United States Army; Col. C. B. Wheeler, of the Army Ordnance Department; G. O. Smith, Director of the Geological Survey; Col. C. Keller and Capt. C. L. Sturdevant of the Army Engineers; O. C. Merrill, Engineer of the Forestry Service; C. L. Parsons, Chief Chemist of the Bureau of Mines, and J. N. Carothers, of the Bureau of Soils.

Columbia, S. C., was the first city visited; Gadsden E. Shand spoke on behalf of the Broad and Saluda Rivers. At Augusta, Ga., W. H. Burr presented the engineering advantages of the development of the Savannah River, where two developments, 20 miles apart, would provide 92,000 hp. At Atlanta, Ga., hearings were held on the Chattahoochee and the Coosa River, advocated separately. B. M. Hall discussed the engineering features of the former, where 100,000 hp. is available; C. G. Adsit, engineer for the Georgia Railway and Power Co., described the hydro-electric advantages of the Coosa. At Birmingham, W. G. Waldè, of Nashville, presented the claims for Muscle Shoals, where 680,000 hp. can be obtained, it was stated. A steam plant at Tuscaloosa, Ala., in combination with water-power at the locks on the Warrior River was the suggestion at the Tuscaloosa hearing. At Nashville, it developed that the City of Nashville favored Muscle Shoals, but representatives of towns on the upper Cumberland River argued in favor of that district and said that 75,000 kw. could be developed. At Louisville, Ky., the board heard argument in favor of the use of the falls of the Ohio River, by which 50,000-hp. could be developed for ten months a year, with supplementary steam power. At Wheeling, W. Va., the construction of a steam plant was urged.

The board will next visit Western sites and following this trip will be able to report to the president. At the same time, reports of the American Academy of Sciences on the question of processes will be presented.

Three-Fourths of Second Simplon Tunnel Completed

In spite of constant labor difficulties during the past two years the second Simplon tunnel has progressed to over 75% completion. The report for January, 1917, shows that of the total length of 19,825 m. there has been driven 15,597 m. of top heading (the bottom heading was driven as pioneer heading at the time the first tunnel was built), and only 140 m. less of full excavation was made.

The masonry lining has been completed on a length of 15,058 m., or 76% of the final length; of this about 8000 m. is in the south end and 7000 m. in the north end. The working force is now slightly under 1000.

Poor Sewers Worse Than None

That the inadequacy of sanitary sewers in certain sections of Birmingham, Ala., has developed conditions worse than those prevailing in districts without sewers is the declaration contained in a formal statement issued by J. D. Truss, Commissioner of Public Works and a civil engineer. The absence of storm sewers to carry off the rainfall causes the sanitary sewers to become flooded in heavy rainfall and the sewage to overflow in basements and streets. One section unprovided with sewers failed to report a single case of typhoid fever during an epidemic last summer, while an important residential section, which was sewered, had the largest amount of typhoid. Commissioner Truss said: "From my observation I think an inadequate sewer system is worse than no sewer at all. Birmingham's system is inadequate and should be considered a disease spreader instead of a filth carrier." He urges that storm sewers be built, beginning at the lower edge of the drainage area.

Bascule Bridge Drops on Steamer

The south leaf of the Broadway bascule bridge over the Milwaukee River at Milwaukee, Wis., dropped about 3 a.m., Mar. 14, striking the pilot house and bridge of steamer "No. 3" of the Pere Marquette Line. The damage done is estimated at $2000 to $4000 for the steamer, but only about $100 for the bridge. Witnesses state that this leaf was raised for the steamer and then lowered just before it entered the draw; it was raised a second time and then lowered again, striking on the pilot house. As the boat's bridge was torn away, it caught the whistle

cord and signaled the engineer for full speed ahead; and at the same time the wheel was also caught, turning the rudder so that the boat swerved to one side and ran into the dock before it could be stopped. This was very fortunate, as had the rudder not been turned, the boat would probably have gone into the Chicago & Northwestern Ry. bridge a few hundred feet below, before the engineer could have been notified to stop the engines. The only personal injury was to one of the boat's crew, who was slightly cut by flying glass.

Because of the fact that a new center lock was being put on the bascule and also because some changes were being made in the electrical equipment, it was at first feared that something had gone wrong with the machinery. Consequently, the Field Superintendent of Bridges (of the city's Department of Public Works) immediately called the Bridge Electrician, and they both arrived at the scene about 3:45 a.m. A careful examination convinced them that everything about the structure was in first-class working condition. They then operated the bridge several times, with results that substantiated their conclusions. The bridge tender seemed to be at a loss as to just what had happened, but thought the brakes were not working. These, however, were found to be in perfect adjustment and held the bridge in any position desired. This was to be expected, as they had been adjusted but a few days previous to the accident.

As the brakes were in perfect working order at 4 a.m., it hardly seems reasonable that they were in poor order at 3 a.m.; and the two possible explanations of the accident were that the bridge was raised and again forced down by the wind before the bridge tender could set the brakes, or that for some reason or other the bridge tender failed to set the brakes. The first of these seems hardly tenable, as the wind velocity was not exceptionally high (about 15 miles per hour) and that the leaf was twice raised and lowered. It is thought hardly possible that an experienced bridge tender (as this one was) would let his bridge get away from him twice within a few seconds, if he were in full control of his faculties. It seems evident, therefore, that for some reason or other the brakes were not properly handled.

The bridge is of the trunnion type, a double-leaf plate-girder deck span 128 ft. c. to c. of trunnions. Keyed to the trunnions are sector racks gearing with operating pinions. It was described and illustrated in *Engineering News*, July 14, 1904. For information as to the accident we are indebted to J. C. Pinney, Superintendent of Bridges and Public Buildings, Department of Public Works, Milwaukee, Wisconsin.

A Commission-Manager Charter for Kingsport, Tenn., has been enacted by the legislature. The city has grown from 200 to 8000 population within a few years, it is said.

A State Flood Commission for Kansas has been provided in a bill just signed by Governor Capper. It provides for the appointment by the governor of two commissioners, who, together with the governor, constitute the commission. The two appointive members of the board are to be civil engineers. They are to serve without salary, but are allowed actual expenses. State employees may be appointed. The duties of the commission are to investigate the problems arising from floods, and to look after the domestic water-supply, drainage, water power and supply for irrigation purposes. Drainage districts already created are not in any way under the supervision of this commission.

Extension of the Chicago Drainage Canal for two miles at Joliet to a new 24,000-hp. hydro-electric plant on the Des Plaines River is proposed, in order to provide power for operating pumping stations of the Chicago water works. The sustained opposition of the City of Joliet and of private concerns proposing water power projects has been overcome, the city being assured of ample protection against floods and overflow. It is estimated that the extension and power plant will cost about $6,600,000 and that the work can be completed in three years. It is necessary to wait, however, for the passage of a bill by the Illinois legislature authorizing the Sanitary District of Chicago to build the extension, dam and power plant. This bill has been prepared.

Prevention of Further Floods at Chattanooga, Tenn., is being studied following a flood which reached a stage of 47.7 ft., 30 ft. above flood stage, on Mar. 7. The damage to factories, houses, roads, etc., is estimated at $1,000,000. Consideration is being given to the construction of a levee system and the Southern Ry. has directed R. W. Jones, Resident Engineer, to make surveys to estimate the cost of levees for protection against a 54-ft. stage. The Chattanooga-Hamilton County Flood Prevention Association was formed at the same time by local business organizations and will ask the legislature to authorize a vote on a $500,000 bond issue for flood prevention. Three levees are planned to protect lowlands along the river, with floodgates to protect Citico and Chattanooga Creeks, the backwater of which causes considerable damage at high stages of the river. One or more pumping stations to take care of flooded low areas are planned. Congress is to be asked to appropriate $1,000,000, under the plan for flood-prevention work on the Mississippi and Sacramento Rivers, by which the Federal Government gives twice the amount provided by local interests. Sanitary work in the flooded district has been placed under the direction of G. W. Knight, a sanitary engineer, of Chattanooga, and a volunteer committee. The measures taken include the requirement that every house must be thoroughly cleaned and lime used liberally before being occupied; pouring oil in wells along the river used as water-supplies; and disinfecting of all sources of contamination. In adddition, many houses considered unsanitary have been condemned.

PERSONALS

Sydney O. Swenson, M. Am. Inst. E. E., has left the engineering staff of Putnam A. Bates, New York City.

J. C. Halsema, H. C. Buckland and **E. D. Fitchner** have organized a contracting company in Jacksonville, Fla.

M. B. Myers, formerly Assistant to the Vice-President of the American Manganese Steel Co., has been appointed Sales Manager, with headquarters in Chicago.

P. D. Van Vliet has been appointed Publicity Manager of the Universal Portland Cement Co., Chicago. Mr. Van Vliet has been connected with the department some years.

C. C. Jones, formerly in the engineering department of the Chicago, Milwaukee & St. Paul Ry., has become senior member of Jones & Bohmke, engineers and contractors, Hutchinson, Kan.

E. B. Goode, for four years Metropolitan District Sales Manager for the Lehigh Portland Cement Co., has been appointed Sales Manager of the Hercules Cement Corporation, with offices at 30 East 42nd St., New York City.

John C. Hiteshew, formerly City Engineer of Carlisle, Penn., has been appointed Borough Engineer and Commissioner of Streets for Waynesboro, Penn., to succeed George C. Brehm, who resigned several weeks ago to take up similar work in Massachusetts.

M. D. Gates, formerly Chief Engineer of the Boyne City, Gaylord & Alpena R.R., has resigned to form a partnership with C. E. De Leuw, former Assistant Engineer for Ewing & Allen, Chicago. The firm of Gates & De Leuw will have offices in the Monadnock Block, Chicago, and will specialize in municipal and drainage engineering.

C. A. F. Flagler, Lieutenant-Colonel, Corps of Engineers, U. S. A., in charge of the Washington (D. C.) Engineering district, has been designated Military Attaché at Rome, succeeding Maj. Elvid Heiberg, who was accidentally killed by a fall from his horse on the Italian front. No one has been appointed to succeed Colonel Flagler as yet.

C. S. Cook, Manager of the Railway and Lighting Department of the Westinghouse Electric and Manufacturing Co., has been appointed General Manager of the Duquesne Light Co., succeeding the late Robert S. Orr. Mr. Cook was born in Massachusetts, was graduated from the Worcester Polytechnic Institute in 1887, and was employed by the Westinghouse company in that same year.

Julian C. Smith, Fel. Am. Inst. E. E., M. Can. Soc. C. E., M. British Inst. E. E., was recently awarded the Gzowski medal of the Canadian Society of Civil Engineers for his paper on the Cedars Rapids Power Development. He was born in Elmira, N. Y., in 1878, completed the mechanical engineering course at Cornell University, and is now General Manager of the Shawinigan Water and Power Co. He was chief engineer of the Cedars project during its design and construction.

E. M. Durham, Jr., who has recently been appointed Assistant Chief Engineer of Construction of the Southern Railway, was general agent of the executive department for the road and its subsidiaries, with headquarters at Chattanooga, Tenn. He graduated from Lehigh University in 1896 and entered the service of the Southern Railway in 1900 as assistant engineer at Selma, Ala. He was made assistant chief engineer in charge of construction in the Mississippi delta in 1906 and in 1914 he became special engineer of valuation of the Atlanta, Birmingham & Atlantic R.R. His appointment as general agent at Chattanooga was made on Nov. 1, 1915. He will remain at Chattanooga for several months, in charge of construction in the Middle South.

OBITUARY

J. J. von Weyrauch, of the faculty of the Stuttgart Technische Hochschule for 41 years until his retirement in 1915, died at Stuttgart, Germany, on Feb. 13, 1917. He had reached the age of 71.

Willard Wendel White, civil engineer, at one time with the Boston & Maine R.R., and later in private practice, died recently in Boston. He was born in Natick in 1848, graduated from Sheffield Scientific School, Yale, in 1869, and for the past nine years had resided in Wellesley Hills. He was a member of the Boston Society of Civil Engineers.

George Christoph Mehrtens, prominent for many years as an expert in bridge construction, died at the age of 73 on Jan. 10, 1917, at his home in Dresden, Germany. For many years he was professor of structures at the Dresden Technische Hochschule. He entered the editorial field some years ago with the journal "Der Eisenbau," in whose publication he was one of the leaders.

Ferdinand W. Roebling, Treasurer and General Manager of the John A. Roebling's Sons Co., Trenton, died at his home in that city on Mar. 16, following a month's illness. He was born in Saxonburg, Penn., in 1842. He is the son of John A. Roebling, the pioneer wire-rope manufacturer in this country. Following graduation from the Polytechnic College, Philadelphia, he specialized in chemistry. John A. Roebling began the manufacture of wire rope at Saxonburg in 1840, transferring his plant to Trenton in 1848. Ferdinand Roebling was a member of the local Engineers' Club.

Reuben Miller, prominent in the steel industry, died on Mar. 5 in Pittsburgh, at the age of 76. He was born in Pittsburgh and became an apprentice in the works of Robinson, Miner & Miller, designers and builders of Clinton furnaces, later becoming mechanical engineer at the Black Diamond works of Park Bros. & Co. Later he became a partner in Miller, Barr & Parker, which concern 10 years later took the name of Miller, Metcalfe & Parker, eventually being merged with the Crescent Steel Co. He then became Chairman of the Board of Directors of the Crucible Steel Co., and retired from active business in 1914.

John F. Alden, M. Am. Soc. C. E., a former Director of the American Bridge Co., died at his residence in Rochester, Feb. 27, at the age of 65 years. He was graduated at the Rensselaer Polytechnic Institute, in the class of 1872, and was for years a builder of steel bridges, especially for railroads. He organized and was proprietor of the Rochester Bridge and Iron Works, which he sold to the American Bridge Co., in 1901. He was a member of the Rochester Society of Engineers, at one time a Vice-President of the American Society of Civil Engineers, a Director of the Traders' National Bank of Rochester and the Genesee Valley Trust Co., and President of the Locke Insulator Co.

Oscar G. Murray, Chairman of the Board of Directors of the Baltimore & Ohio R.R., died in Baltimore, Md., on Mar 14, at the age of 69 years. He was born in Bridgeport, Conn., and after an extensive railway experience became Vice President in charge of traffic of the Baltimore & Ohio R.R. in 1896, and in the same year was named by the United States Court as a co-receiver with the late John K. Cowen. In 1900 the receivers were discharged and the property was reorganized, Mr. Murray continuing in charge of the traffic department until 1903, when he was elected president of the railway, succeeding L. F. Loree. In 1910 he was succeeded by Daniel Willard, the present President.

Maj. Cassius E. Gillette, a retired officer of the Corps of Engineers, U. S. A., died at his home in Philadelphia on Mar. 18, aged 58 years. In 1897 Major Gillette was placed in charge of the United States Engineer Office at Savannah, Ga., succeeding Capt. Oberlin M. Carter, who had been stationed at Savannah for an unusually long time and had during that time conspired with Gaynor & Greene, contractors engaged on river and harbor work in the district, to defraud the Government of between $2,000,000 and $3,000,000. Carter was one of the most popular officers in the service and was strongly intrenched socially and politically. One member of the contracting firm was a retired Captain of Engineers and another was Chairman of the New York State Democratic Committee. Major Gillette was a comparatively unknown man, without means or influence. Carter's social standing was such that when Major Gillette, after assuming charge of the Savannah office and making investigations, presented a report to the Chief of Engineers accusing Carter of defrauding the Government, Gillette was ostracized in Savannah society, and many officers of the Corps of Engineers refused to believe in the possibility of Carter's guilt. A board of engineer-officers was appointed to investigate the charges, and on their report Carter was court-martialed. At the conclusion of the longest trial ever held by the United States Army, he was convicted and sentenced to imprisonment at Fort Leavenworth. Following that the contractors were also convicted and sentenced; and at the end of court proceedings, which lasted more than a dozen years, the Government recovered a considerable amount of the funds which Carter had obtained as a result of the fraud. The result of these trials was due more than anything else to the ability with which Major Gillette presented the Government's case. A number of years later, serious frauds were discovered in connection with the contracts for the Philadelphia water-filtration plant, and a reform administration in Philadelphia appealed to the War Department for assistance in reorganizing the Water Department on a business basis. President Roosevelt agreed to give Major Gillette a leave of absence from the Corps to undertake the work for the City of Philadelphia. Political influences in Congress attempted to prevent this by the passage of legislation to prevent such work by an engineer-officer, and to meet this situation Major Gillette resigned from the Corps. He was in charge of the Philadelphia Water Department during the completion of the filtration work, and when the reform administration which had employed him got out of power he opened an office for the practice of consulting engineering. He was chief engineer for a Philadelphia syndicate which undertook large mining and land development enterprises in Mexico, which were very prosperous until interfered with by the Mexican revolution. Major Gillette is survived by his widow, one son who graduated from West Point and is a Lieutenant in the regular army, and two daughters.

ENGINEERING SOCIETIES

ILLINOIS GAS ASSOCIATION.
Mar. 21-22. Annual meeting in Chicago. Secy., Horace H. Clark, 1325 Edison Building, Chicago.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 20-22. Annual meeting. Congress Hotel, Chicago. Secy., E. H. Fritch, 900 South Michigan Ave., Chicago.

ST. LOUIS RAILWAY CLUB.
Apr. 13. Secy., B. W. Frauenthal, Union Station, St. Louis.

DETROIT ENGINEERING SOCIETY.
Apr. 21. Secy., D. V. Williamson, 46 Grand River Ave., W., Detroit.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
Apr. 26-28. In Dallas. Secy., H. S. Cooper, 405 Slaughter Building, Dallas, Tex.

Illinois Section American Water-Works Association At the annual meeting held at the University of Illinois, Mar. 13-14, officers were chosen as follows: Chairman, Emmett MacDonald, Lincoln, Ill.; vice chairman, W. W. DeBerard, Chicago; secretary, Dr. Edward Bartow, Urbana, Ill.

American Institute of Electrical Engineers—E. W. Rice, Schenectady, N. Y., has been nominated for president at the meeting of the Board of Directors held in Chicago on Mar. 9. The other nominations are: For vice presidents, Frederick Bedell, John H. Finney, A. S. McAllister; for treasurer, George A. Hamilton.

Vermont Society of Engineers—The annual meeting of the Vermont Society of Engineers was held in Burlington, Mar. 11. A feature of the three sessions were the reports of standing technical committees on public policy, roads and pavements, power development, mechanical and electrical science, railroads and structural engineering, sanitation and public health, and natural resources. The individual members of these committees presented brief papers on various aspects of these subjects as encountered in the state. The following new officers were elected: President, Prof. A. E. Winslow, Norwich University, Northfield; vice president, C. F. Purinton, Leader Evaporator Co., Burlington; secretary-treasurer, G. A. Reed, City Engineer, Montpelier. The last-named office is a consolidation.

Appliances and Materials

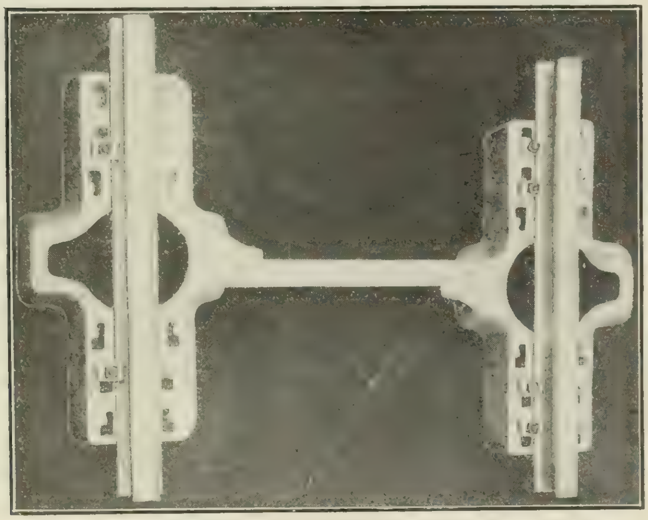
New Zinc, Tin and Lead Coatings

A method of securing a protecting coat of zinc, tin or lead alloys on steel or copper products, new to this country, is being promoted by Henry Hess & Son, of Philadelphia. The various materials entering this process carry the trade name "Epicassit" and have been used for some time in Germany. Metal powder is mixed with a liquid vehicle and applied with a brush. Then the supporting metal to be coated is heated to the melting point of the tin, lead or zinc. Where possible the heat is to be applied on an uncoated side, but objects may be heated over a fire or in a clean flame. Grease, rust, burnt coatings, etc., must be removed. The following coatings are available: "A," pure tin; "B," $\frac{2}{3}$ tin and $\frac{1}{3}$ lead; "C," $\frac{1}{3}$ tin and $\frac{2}{3}$ lead; "CN," 5% tin and 95% lead; "E," 35% tin with 15% lead and 50% zinc. The latter is a substitute for "galvanizing."

* * *

New Cast-Steel Tie

The metal tie shown in the accompanying view is composed of two cast-steel blocks connected by a tie-bar. The blocks are about 46 x 22 in. and 5 in. deep, laid with the longer dimension parallel with the rail. Slotted holes hold the heads of bolts to which the rail clips and nuts are fitted. The weight of the tie complete is about 200 lb. Some of the ties have been laid experimentally on an industrial spur. This tie is the invention of Joseph A. Silver, 854 West 181st St., New York, and is being handled by the Silver Steel Tie Co., Merchants Bank, Salt Lake City, Utah.



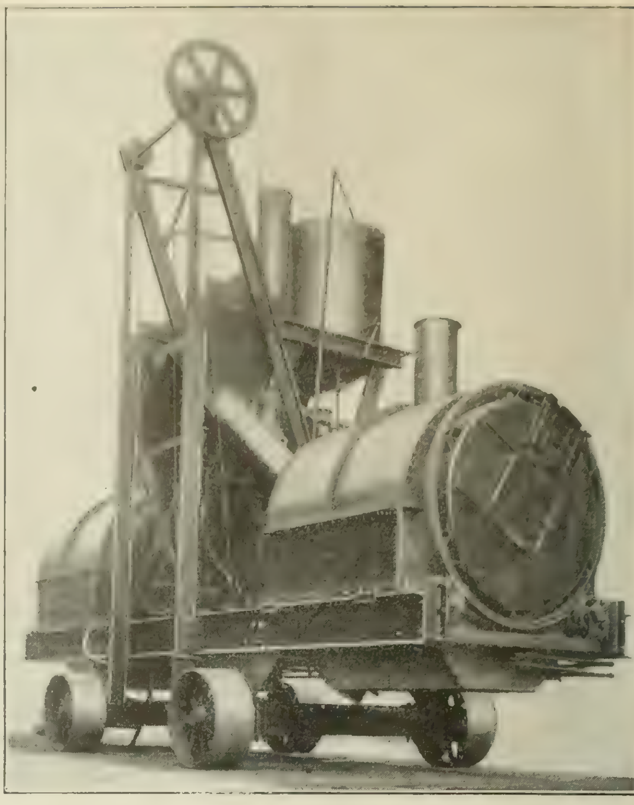
SILVER'S CAST-STEEL TIE

* * *

Asphalt-Mastic Mixing Machine

The Iroquois Works of the Barber Asphalt Paving Co., Buffalo, N. Y., has placed on the market an asphalt-mastic mixing machine designed to replace the usual pot method of melting prepared mastic cakes, by combining the necessary ingredients at the site of the work. The machine consists of two rotating mixing drums driven through gears by a steam engine. The boiler is mounted between the drums and is designed to use oil fuel. A skip and elevator are provided for hoisting the materials to an elevation where they will run into the drums, which are heated by oil burners under them.

The mixing drums are cylindrical, each resting on four wheels or rollers, which engage with rails on the drum. The drums are provided on the interior with flights so arranged as thoroughly to mix the ingredients. The heads of the drums have openings for receiving the materials and for discharging the heated mastic. Either drum may be rotated independently of the other, the intention being to fill and empty them alternately. The drums are surrounded by housings that contain the oil-fired furnaces. The whole machine is mounted on four steel wheels. It is 18 ft. long over all and 7 ft. 3 in. wide over the wheels. The width over the skip is 10 ft. The shipping height is 10 ft. 7 in. and the operating height 16 ft. The whole machine weighs about 8½ tons.



DOUBLE-DRUM ASPHALT-MASTIC MIXING MACHINE

* * *

Power Unit for Section Cars

For converting a hand-car into a power-operated section car a kerosene-engine unit has been devised. This, with all accessories, is mounted on a frame about 6 x 2 ft., which can be fitted to the car in very short time. The 5-hp. engine has a single, horizontal air-cooled 4 x 4-in. cylinder and two 16-in. 55-lb. flywheels. A belt runs over a 4½-in. pulley on the engine shaft and a 14-in. pulley fitted to one of the car axles. The engine starts on gasoline (for a few strokes only), and it is stated that the machine can run 35 to 40 miles on a gallon of kerosene. The car has a maximum speed of 15 miles per hour and can haul a supply car, as shown in the accompanying view. The outfit weighs about 415 lb., with batteries, 1½-gal. fuel tank and all equipment. It is known as the "Sheffield Power-Top" and is being introduced by Fairbanks, Morse & Co., of Chicago.

HAND-CAR CONVERTED INTO A SECTION MOTOR CAR

Engineering News

VOLUME 77 MARCH 29, 1917 NUMBER 13

Arcaded Cantilevers Cased in Concrete Feature a Million-Dollar Bridge

SYNOPSIS—Hanover St. bridge, in Baltimore, looks like a succession of concrete arches but in reality consists of steel and concrete cantilevers.

Replacing the old wood trestle and steel swing bridge across the Patapsco River at Light St. in southern Baltimore, a concrete "arch" bridge just completed forms a new thoroughfare across the estuaries of Patapsco River and Middle Branch. The consulting engineer, J. E. Greiner, was given the task of designing a bridge of graceful or even monumental appearance and of permanent type, which appeared to mean a reinforced-concrete arch bridge. However, as in his judgment it was impracticable to found an arch bridge in the soft mud bottom, he devised a cantilever design, as shown by the drawings herewith.

Cantilever construction to secure a concrete-arch effect has been used before in two or three cases, as cited in *Engineering News* of Mar. 25, 1915 (p. 579), and Apr. 22, 1915 (p. 790). The 100-ft. span of the Deer Creek bridge at Husbands Ford, Md. (L. F. Smith), and the 95-ft. span of the Chester Creek arch at Fifth St., Chester, Penn. (H. H. Quimby), are the most important of these. They are single-span structures, however. The Hanover St. bridge comprises a whole series of spans, each equal to the single span of the Deer Creek and Chester bridges, and totaling 2280 ft. It is thus the most prominent application of the reinforced-concrete cantilever principle to date. The finished bridge, as built under charge of H. G. Shirley, Chief Engineer of the State Roads Commission of Maryland, and Mr. Greiner as Consulting Engineer, is accurately portrayed by the two bird's-eye views in Fig. 1, reproduced from drawings by E. W. Spofford. They show typically the arch-like appearance secured. If a view like Fig. 3 is studied, however, the joint in the arch crown shows the separation between the ends of the adjacent cantilevers.

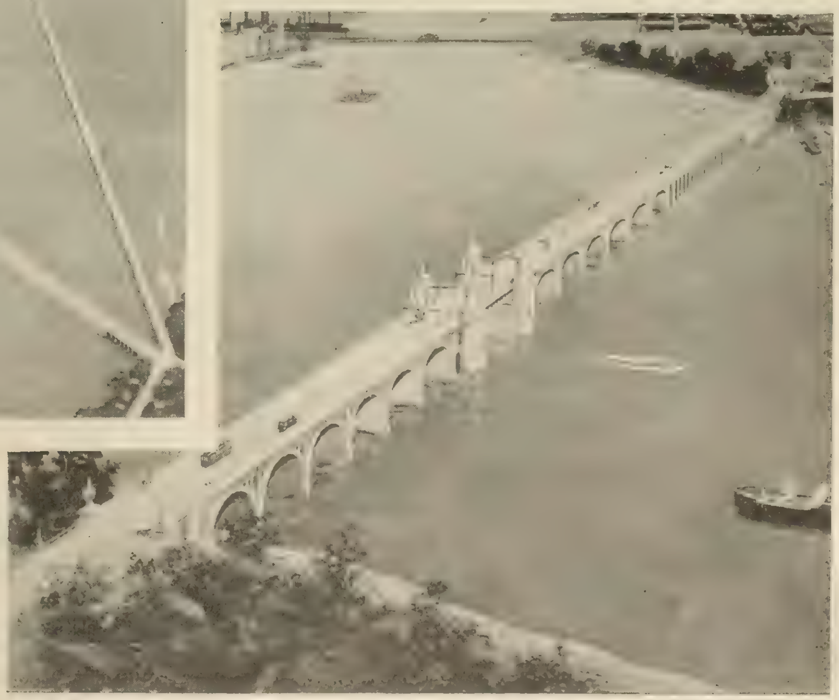


FIG. 1. BIRD'S-EYE VIEWS OF HANOVER ST. BRIDGE LOOKING NORTH

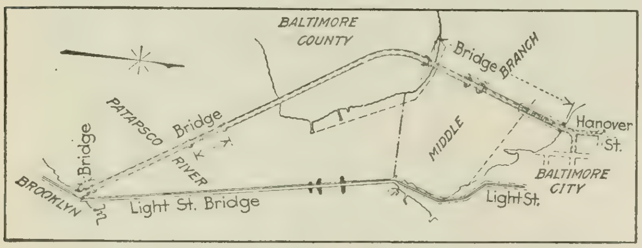
The location (see sketch in Fig. 1) lies west of the Light St. bridge and traverses the point of the peninsula between the two estuaries. The north crossing is the main one; it consists of spans of the arch-cantilever type, all of them 95-ft. in the clear, and a 150 ft. Rall two-leaf bascule. The south crossing is mostly earth fill, but it has two concrete column-and-girder openings, 512 ft. and 105 ft. wide respectively. The smaller one, seven 15-ft. spans, has ordinary reinforced-concrete girders. The larger contains 16 spans of 30 ft. and one of 32, and here, to save falsework, the reinforcement was made of structural steel frames designed strong enough to carry the forms and the rib concrete (but not the floor slab).

In both crossings the soil was mud to depths of 70 to 100 ft. Foundation on piles was adopted. Some doubt as to the bearing power of the piles was caused by the presence of a hard stratum below El. —70, under which was a further 10- to 15-ft. layer of mud. The final decision was to drive until the penetration did not exceed ½ in. per blow in the last five blows of a 3000-lb. hammer falling 15 ft. In general, this meant that the piles stopped in the upper hard layer. The profile in Fig. 4, plotted by R. G. Browning, Resident Engineer, represents the piling as actually put in. The piles range from 65 to 85 ft. long, but in the north approach many 100-ft. piles were driven.

The adopted pile loading is 16 tons. With regard for the possible vibration effects from the bascule, however, longer piles were ordered for the north bascule pier and an extra price was paid to drive beyond the specified resistance. On the other hand, occasional piles in the footings of the northerly half of the structure are under the specifications. Throughout, the driving resistance varied greatly, probably because of lumps of iron ore in the ground.

That the soil conditions are unfavorable to piers carrying horizontal arch thrust became quite evident when the fills of the north approach and of the south crossing were made. Extensive flow of the subsoil developed at the south crossing, the soil being upheaved on either side (Fig. 11) in banks up to 150 ft. wide and 8 to 10 ft. high, where previously there had been 3 to 5 ft. of water.

While the north approach fill of the north crossing was being made, outward displacement of a few column footings occurred due to pressure or flow of the fill. This called for some troublesome repair work. At least one of the footings also underwent abnormal settlement, thought to be chargeable to flow of the mud stratum underlying the first hard crust.



The pier bases are at El. —25, except for the bascule piers, which extend to 10 ft. deeper. They were built in open cofferdams, no special difficulty being encountered. The unusual shape of the piers—shaft of ribbed cross-section on a reinforced bottom slab—deserves notice (Fig. 6).

The Steel-Rib Cantilevers

The "arch" design was practically dictated as to span and intrados outline by the Government's navigation requirement, calling for 26½-ft. clearance height above mean low water on a width of 70 ft. in each span. Spans of 95 ft. with approximately elliptical intrados suited this clearance diagram.

The cantilever rib and its steel cantilever skeleton and backstays are both shown in Fig. 5. The backstays

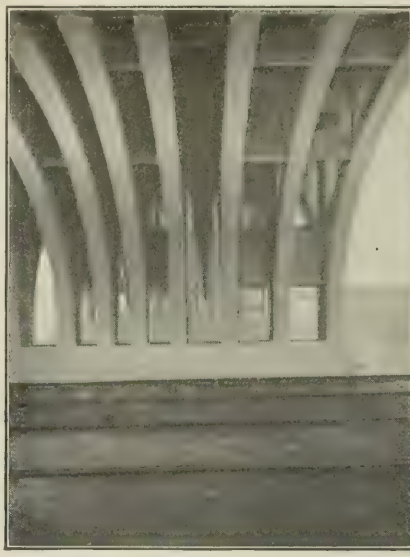


FIG. 2. VIEW UNDER A LAND ARCH BRIDGE

FIG. 3. VIEW SHOWING CROWN JOINT

take full-load tension, but the live-load rib compression is divided between steel and concrete. There are ten ribs, braced in pairs by occasional struts of concrete-incased steel girder makeup. Two steel ribs of adjoining spans, back to back, with anchorage tower between, and their eyebar backstays, were designed to be a unit and were so built. The steel weight, thus, was to be kept balanced at all times. However, the anchorage was proportioned on a more liberal basis, to insure safety under all conditions. The anchor bolts holding the steel tower to the pier were designed for the unbalanced weight of steel and concrete-forms of one cantilever half-span, and for the alternative

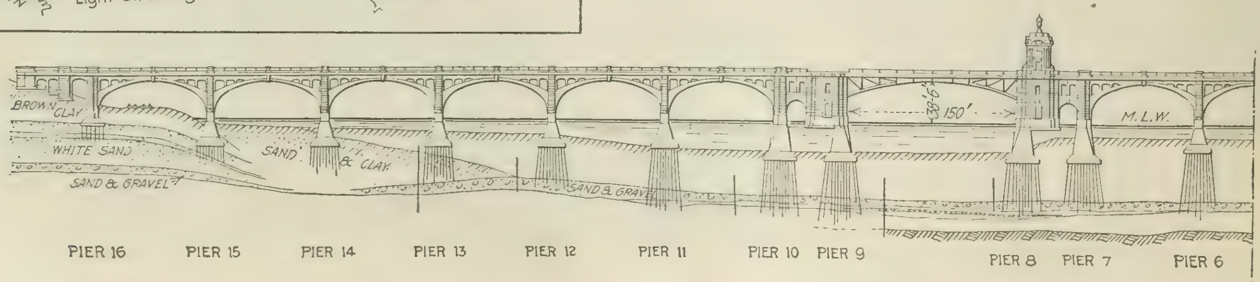


FIG. 4. GENERAL LAYOUT OF HANOVER ST. BRIDGE OVER THE PATAPSCO RIVER AT

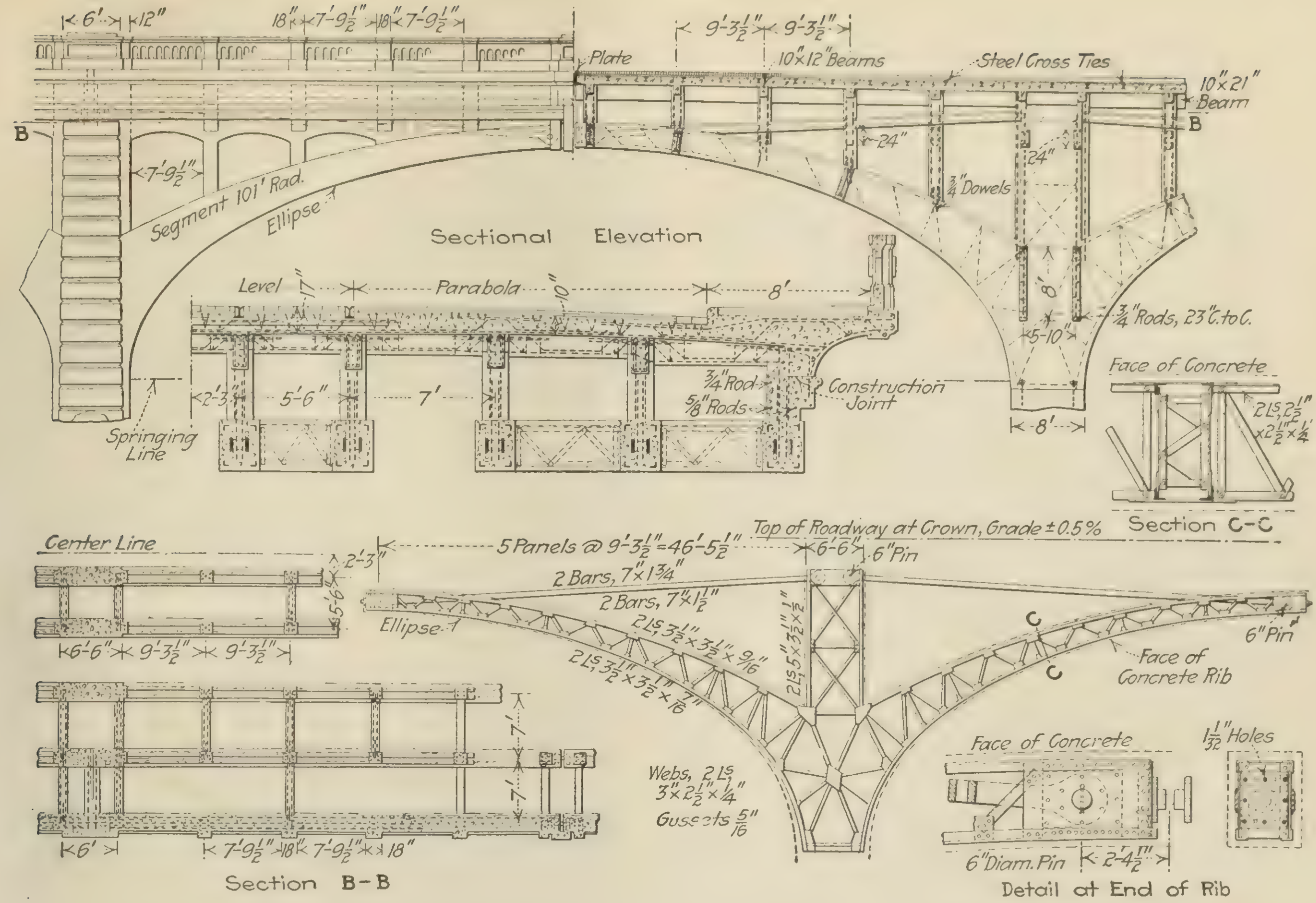


FIG. 5. TYPICAL CANTILEVER ARCH OF HANOVER ST., NORTH CROSSING

condition of balanced steelwork and forms but unbalanced concrete of one-half span. The contractor actually did the work in balanced condition.

Each span is completely cut at the crown, so far as the concrete is concerned. The gap is 3 in. wide. The steel ribs also are kept far enough apart to prevent any butting contact as a result of deflection or settlement, but they are connected by a longitudinal pin which serves as shear tongue, compelling the adjoining ends to deflect equally.

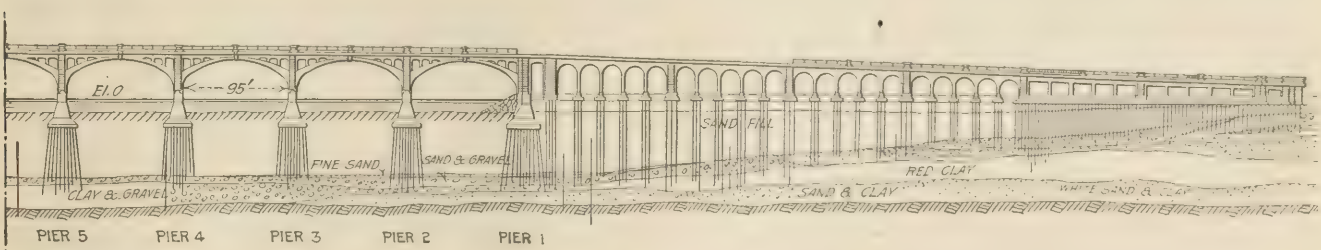
The open spandrels above the ribs were adopted for good appearance as much as for lightness. The roadway, slab and girder work is simple and follows normal practice. For designing the coping and balustrades and the prominent operators' houses at the end of the bascule, the critical coöperation of W. W. Emmert, of the firm of Ellicott & Emmert, architects, Baltimore, was secured.

The steel skeleton work is designed for a tension of 16,000 lb. per sq.in. and a compression of $nf_c = 15 \times 650$ or 9750 lb. per sq.in. Under the most unfavorable liveload the rib flanges are subjected to slight tensile stress in some portions.

Not only were the steel ribs erected as double cantilevers but the whole superstructure concreting was also carried out in these individual umbrella units, without any necessary relation between the two halves of an "arch" except as convenience of work might dictate. The small photographs, Figs. 10 and 11, show such umbrellas.

The steel skeleton of one rib for the whole length of an umbrella, consisting of two half ribs, the anchor tower on the pier, and two backstays, was assembled at the structural shop (Maryland Steel plant at Sparrows Point), forming an erection piece 105 ft. long. It was transported by scow to the bridge site, and there lifted off and set directly to place on the pier. In this setting the deflection of the steel under the weight of the rib concrete (nearly 3 in.) was taken account of. Although the ribs were built with a camber of several inches, in placing them on the piers their tower bases were set 3 in. high to allow further for the deflection of the ends.

Concrete forms were suspended from the steel ribs, after all the ribs of an umbrella had been erected. The ten ribs were then concreted simultaneously. Columns and floorbeams, and the roadway slab, followed.



BALTIMORE AND PROFILE OF SUBSOIL AND BRIDGE FOR THE NORTH CROSSING

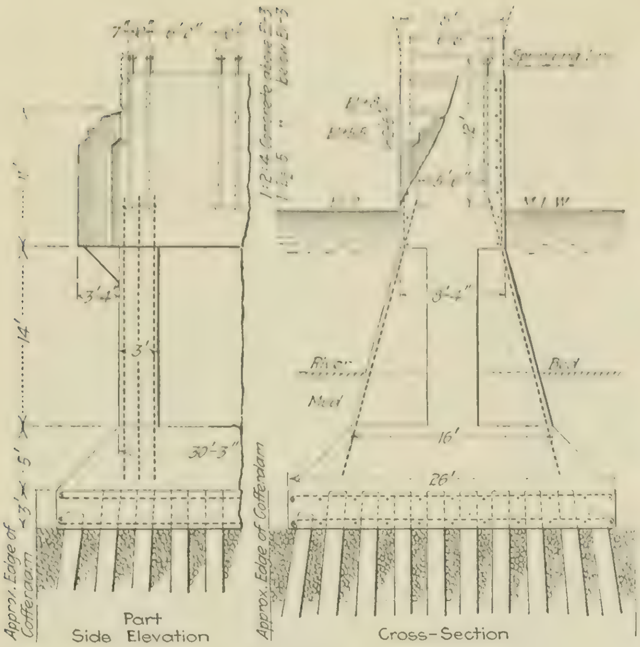


FIG. 6. TYPICAL PIER

A 3-in. opening was left between abutting units at the crown of each arch, in the roadway width; on the sidewalk and in the balustrade the joint width was reduced to 1 in. The wide slot was covered with a steel expansion plate, but the joint in sidewalk and balustrade was made by a thick strip of asphalted felt placed against the face of the section first poured.

The showing faces of the concrete were generally rubbed with carborundum and washed with neat cement wash, but panels of the rib faces and piers were heavily bush-hammered to expose the stone. The surface secured is very uniform and pleasing.

In spring of 1916, soon after the northerly span of the bridge had been concreted, its north pier was found to be something over an inch out of line. The floor slab was not yet placed. The movement was at first chiefly a shifting or tipping forward, so that the shear pin in the end of the one cantilever touched the bottom of its socket. The further shift of the pier was in upstream direction, and slowly increased to 6½ in. It was believed to be caused by creep of the fill which had been deposited back of (and partly around) the pier to inclose the foundation piles of the approach column footings. Flow of this fill had been noticed previously, a short distance to the north.

Dumping riprap along the upstream end of the pier was resorted to, as a means of checking the shift. After a large amount had been put in, measurements showed the pier to have been brought back a slight amount. A total of some 3000 cu.yd. of riprap was dumped, the final result being that the pier is only 5½ in. off line (and slightly forward or south of its original position).

The movement of the pier swung the cantilever which it carries, and this, because of the pin interlock, swung

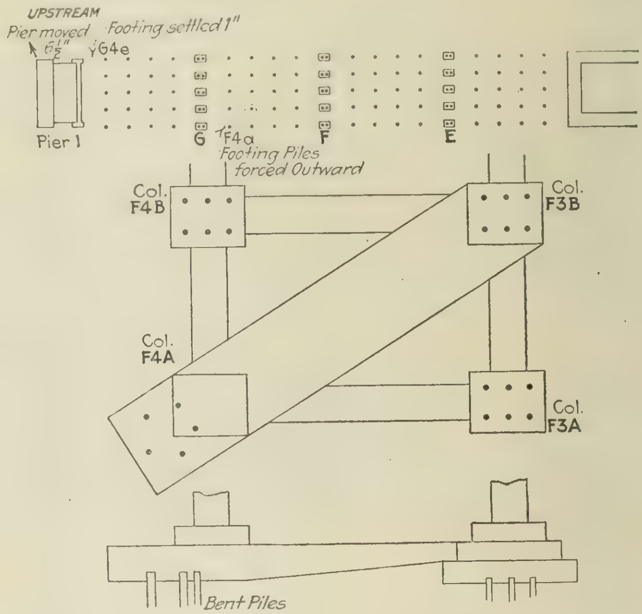


FIG. 8. SKETCH OF RECONSTRUCTED ARCADE COLUMN FOOTING

the next cantilever slightly out of line. However, the floor and balustrade were not yet in place. After the pier was under control, the forms for floor and balustrade and for the curtain wall back of the north pier were built to true line (that is, without regard to the position of the cantilevers).

At the same end of the bridge, where the footings for the retaining-wall and columns of the approach (Fig. 7) are constructed in fill, flow of the fill disturbed several footings. Delay in bringing in the fill led to the start of pile-driving and footing work when only a narrow bank of fill along each side had been deposited. Subsequently, while the center of the fill was being brought to grade, it exerted outward pressure; at footing F4A (see sketch Fig. 8) it forced one of the piles outward, shearing through the 6-in. embedment in the footing concrete. The footings, being held together by reinforced-concrete ties, were not disturbed, but it was thought necessary to reconstruct the damaged one.

This footing was cut loose from its ties, the concrete cut out, and new piles driven. Before these could be capped, however, the continuing flow of the fill forced

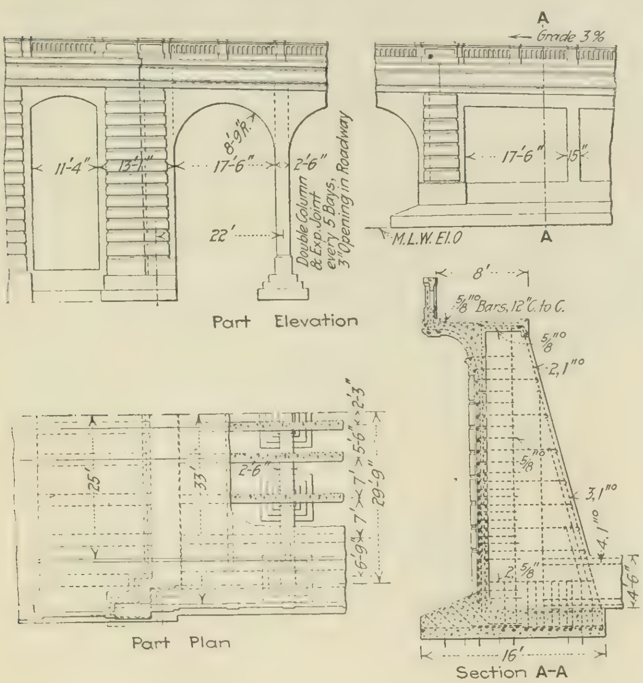


FIG. 7. RETAINING WALL AND ARCADE DETAILS, NORTH APPROACH

their tops several feet outward, so that all but two of the six piles were outside the footing area.

Rather than abandon the new piles, they were used as an offset foundation, by constructing a heavy reinforced-concrete girder joining them to the next footing diagonally back. This girder was connected to the ties leading to the adjacent columns. The footing then could be located on it in true position. No further movement has occurred.

FIG. 9. TWO ADJOINING DOUBLE CANTILEVERS

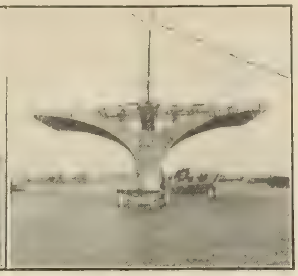


FIG. 10. CONCRETING A DOUBLE CANTILEVER

Settlement of footing G4E, to the extent of about 1 in., was another bit of trouble that developed in the approach. Like the other two cases, it was attributed to effect of the fill, and the engineers expect that after the initial adjustment period, there will be no further movement or pressure.

FIG. 11. UPHEAVED EARTH NEAR NORTHEAST CORNER OF SOUTH CROSSING

Bridge Contract at Low Prices

A prominent feature of this bridge is the fact that low unit-prices were secured. The totals are high, because of the size of the bridge. Including the road through the peninsula, which is a deep cut in hard ground, the total cost will exceed $1\frac{1}{4}$ millions. The three bridges (the north crossing and the two openings in the south crossing) cost $991,000, excluding paving. Some of the subdivisions are: Main bridge, excluding bascule and lighting, $722,000; bascule, $86,000; operating houses, $23,000; lighting, $40,000.

The concrete items include: For foundation concrete, including the cofferdam and excavation, $6.98; for 1:2:4 pier concrete, $7.32; for 1:2:4 arch and floor concrete, $11; for reinforcement, in place, $3.43 per lb.

Work began in September, 1914, and is now completed except for paving. H. P. Converse & Co. were the contractors.

Oregon May Spend Several Millions on State Highways

By Percy A. Cupper*

The Oregon legislature passed some noteworthy highway legislation during its recent session. The state took little part in roadwork until 1913, when the principal state officials were constituted a Highway Commission with power to employ an engineer. At the end of two years a change was made, and the highway work was placed in charge of the State Engineer. In January, when the legislature met again in its biennial session, precedent and political pressure carried the day for an entire change in the manner of handling highway work.

The Highway Commission provided by the new act consists of three non-salaried men appointed by the Governor. This commission is authorized to appoint an engineer to have charge of the construction work. As the office of the commission is at the Capitol and all the commissions reside elsewhere and receive no compensation for their services, the Highway Engineer will of necessity be the active executive officer of the department. A salary not to exceed $5000 (which is equal to the salary of the Governor) is provided for the engineer, and he is authorized to act independently of the commission in conferring with county road officials and furnishing plans. The Highway Commission is authorized to coöperate with the Federal Government. Funds are provided for carrying on coöperative roadwork from a license fee on automobiles, an annual one-fourth mill tax and a bond issue of not to exceed $1,800,000 during the next five years.

In addition the legislature passed an act providing for a bond issue of $6,000,000 to provide funds for hard-surfacing certain roads after the counties have provided the roadbed for the reception of the paving. These funds are not available for coöperative work with the Federal Government and may be expended only upon roads designated as hard-surface roads, post roads and forest roads. This act will be voted on by the people at a special election on June 4.

Another important change in the Oregon road laws was the abolishment of the old road-supervisor system, with its loose, extravagant and inefficient method of handling road funds and the substitution of a county roadmaster in each county acting under the direction of the County Court. This concentrates power and responsibility and makes possible the systematic expenditure of road funds and the adoption of uniform methods of construction.

State Ownership of Electric Central Stations is making rapid progress in Germany, according to a review in London "Engineering." In the kingdom of Saxony a law was enacted last spring providing for a state supply of electric energy. The Government has purchased extensive lignite mines and plans to build large electric generating stations at the mines, from which the current will be transmitted to any desired point. The Diet recently appropriated 20,000,000 M. to begin the work, which will require a total of between 100,000,000 and 200,000,000 M. The Government proposes first to take over the business of the private companies now engaged in supplying electric current, but will later on supply current to the municipally owned stations as well. It is of interest to note that in 1914 the municipal electric works in Saxony had about 150,000 kw. of machinery installed, while the electric central stations owned by private companies had about 80,000 kw. In Bavaria, also, plans have been matured for a state-owned and operated electric central plant, and the work has been approved by the Bavarian Diet.

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A Safe Method Proposed for Estimating Minimum Rainfall

By James P. Wells*

SYNOPSIS—From a study of long-time rainfall records in the United States it is concluded that minimum-mean factors afford a safe basis for estimating minimum rainfall.

It is a matter of common knowledge among engineers engaged in hydraulic work that extreme conditions of rainfall and runoff are far more important than average conditions. Too often has it been the case that large sums of money have been invested in hydraulic projects only to find, upon the occurrence of a dry year, that there has been an insufficient supply of water, resulting in considerable financial loss. Such dry years are invariably due to low rainfall conditions. Though not following any exact formula or rule, the amount of runoff will vary with the rainfall. Few, if any, streams have records of runoff as long as records of rainfall, and it seldom happens that the stream-flow records have been kept in the year of lowest rainfall. While a forty-year rainfall record would be considered good, a complete ten-year record of stream flow would be considered exceptionally good. Also, in many districts only very short records of precipitation are available. In view of the foregoing facts, in order to conservatively estimate minimum runoff conditions, it is essential to have some safe method of determining the minimum rainfall that will occur during a long period of years.

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With the idea of finding some way of safely estimating the minimum rainfall, the writer has gone over all the long records kept by the United States Weather Bureau up to 1909, as published in the climatological summaries, and has tabulated the mean, minimum and maximum annual precipitation. The relations between these records have been calculated and called maximum-minimum, maximum-mean and minimum-mean rainfall factors. From the practical viewpoint, inasmuch as minimums are of prime importance, the minimum-mean is the most useful and important of these factors.

Minimum-Mean Factor for Different Regions

On the accompanying map the minimum-mean rainfall factor has been plotted for a great number of stations throughout the country. An examination of this map shows several important facts in regard to the variations in this factor for different localities. In the eastern half of the country there is a marked tendency toward uniformity. East of the Mississippi River, with the exception of the State of Wisconsin, the factor for by far the greater number of stations is about 0.7 for records of 40 or 50 years. In the southwestern portion of the Mississippi valley it is about 0.5 and in the northwestern portion about 0.6. There is also a tendency toward uniformity in the northwestern Pacific Coast

MINIMUM-MEAN RAINFALL FACTORS FOR STATIONS IN THE UNITED STATES WITH LONG RECORDS

RAINFALL FACTORS FOR UNITED STATES

Stations	Years	Mean	Max.	Min.	Max./Min.	Max./Mean	Mean/Min.	Min./Mean
Maine								
Eastport	36	42.90	64.53	22.84	2.8	1.5	1.9	0.53
Portland	39	42.63	59.24	30.74	1.9	1.4	1.4	0.72
Lewiston	34	45.35	58.61	32.74	1.8	1.3	1.4	0.72
Orono	37	43.18	53.74	29.03	2.4	1.4	1.5	0.67
Gardiner	65	43.06	55.47	30.19	1.8	1.3	1.4	0.71
New Hampshire								
Concord	52	39.82	54.51	26.25	2.1	1.4	1.5	0.65
Hanover	57	35.72	55.85	24.30	2.3	1.6	1.5	0.68
Vermont								
Burlington	64	32.68	49.44	20.99	2.4	1.5	1.6	0.64
Massachusetts								
Boston	91	44.70	67.72	27.20	2.5	1.6	1.7	0.60
Springfield	52	45.36	57.97	30.90	1.9	1.3	1.5	0.68
Lawrence	43	42.96	58.70	31.35	1.9	1.4	1.4	0.72
New Bedford	93	46.58	65.41	34.51	1.9	1.4	1.4	0.74
Worcester	49	45.12	61.83	32.50	1.9	1.4	1.4	0.72
Connecticut								
New Haven	57	45.89	60.26	33.89	1.8	1.3	1.4	0.73
Middleton	36	49.25	68.77	37.08	1.9	1.4	1.3	0.75
Wallingford	43	49.48	63.12	37.88	1.7	1.3	1.3	0.76
Hartford	47	44.30	55.81	33.47	1.7	1.3	1.3	0.75
Rhode Island								
Providence	77	45.31	63.50	30.51	2.1	1.4	1.5	0.67
New York								
Plattsburg	57	30.52	46.80	18.91	2.5	1.5	1.6	0.61
Albany	84	38.39	56.78	26.98	2.1	1.5	1.4	0.70
Troy	59	36.50	49.16	18.32	2.7	1.5	2.0	0.50
New York	84	42.47	59.68	28.78	2.1	1.4	1.5	0.67
West Point	48	46.37	63.56	30.64	2.1	1.4	1.5	0.60
Utica	36	42.14	65.58	33.16	2.0	1.5	1.3	0.78
Oxford	41	40.63	60.63	29.13	2.1	1.5	1.4	0.71
Cooperstown	56	40.09	58.11	29.92	2.0	1.4	1.4	0.74
Sacketts Harbor	44	32.46	55.73	21.67	2.6	1.7	1.6	0.64
Lowville	43	36.48	48.61	26.47	1.8	1.3	1.4	0.72
Penn Yan	60	28.99	44.36	19.66	2.2	1.5	1.5	0.67
Palermo	53	37.01	54.17	24.19	2.3	1.5	1.5	0.65
Oswego	54	36.92	56.16	25.93	2.1	1.5	1.4	0.70
Ithaca	48	32.97	46.39	21.20	2.2	1.4	1.5	0.66
Auburn	41	36.47	49.82	21.74	2.3	1.4	1.7	0.59
Rochester	80	33.34	49.89	17.04	2.9	1.5	2.0	0.51
Fort Niagara	37	27.52	50.49	16.44	3.1	1.8	1.7	0.50
Buffalo	53	37.19	60.24	27.27	2.2	1.6	1.4	0.73
Pennsylvania								
Erie	35	38.15	55.04	26.72	2.1	1.3	1.4	0.70
Pittsburgh	61	36.17	50.61	25.73	2.0	1.4	1.4	0.71
Wellsboro	34	46.08	85.07	31.79	2.7	1.8	1.4	0.69
Morrisville	54	43.34	57.00	30.34	1.9	1.3	1.4	0.70
Philadelphia	38	40.88	51.87	31.03	1.7	1.3	1.3	0.75
West Chester	48	49.86	73.00	33.03	2.2	1.5	1.5	0.66
New Jersey								
Paterson	36	52.20	85.99	41.42	2.1	1.6	1.3	0.79
South Orange	38	48.31	86.81	35.62	2.3	1.6	1.4	0.73
New Brunswick	55	47.84	61.30	33.35	1.8	1.4	1.4	0.69
Atlantic City	35	40.92	61.11	28.13	2.2	1.5	1.5	0.68
Newark	65	47.75	69.10	31.47	2.2	1.4	1.5	0.65
Moorestown	45	45.89	65.21	35.90	1.8	1.4	1.3	0.78
Rancocas	45	47.73	61.72	32.61	1.9	1.3	1.5	0.68
Maryland								
Baltimore	39	43.06	62.35	31.57	2.0	1.5	1.4	0.73
Fallston	39	47.66	70.17	38.06	1.8	1.5	1.3	0.79
Cumberland	37	[illegible].85	52.42	19.96	2.6	1.5	1.5	0.58
District of Columbia								
Washington	72	40.80	61.33	18.79	3.3	1.5	2.2	0.46
West Virginia								
Morgantown	32	44.88	69.54	28.15	2.5	1.5	1.6	0.62
Wytheville	36	40.90	62.65	24.38	2.6	1.5	1.7	0.59
Virginia								
Lexington	36	41.10	60.04	30.46	2.0	1.5	1.4	0.74
Richmond	36	42.99	72.09	27.65	2.6	1.7	1.6	0.64
Fort Monroe	52	42.60	74.11	19.32	3.9	1.7	2.2	0.45
Norfolk	38	49.29	70.72	38.08	1.9	1.4	1.3	0.79
North Carolina								
Weldon	36	47.22	59.58	30.18	2.0	1.3	1.6	0.63
Hatteras	34	60.21	102.04	40.13	2.5	1.7	1.5	0.66
Wilmington	38	50.88	86.65	40.42	2.1	1.6	1.3	0.79
Lenox	34	51.78	64.00	41.39	1.5	1.2	1.3	0.79
South Carolina								
Camden	42	44.18	58.65	30.37	1.9	1.3	1.5	0.68
Pinopolis	42	49.14	65.88	33.49	2.0	1.3	1.5	0.68
Charlestown	115	48.59	78.42	23.69	3.3	1.6	2.1	0.48
Georgia								
Rome	50	47.32	68.56	31.50	2.2	1.5	1.5	0.66
Augusta	40	46.94	57.19	19.13	3.0	1.2	2.5	0.40
Savannah	60	50.06	73.36	33.50	2.2	1.5	1.5	0.66
Florida								
Jacksonville	51	52.53	82.00	37.88	2.2	1.6	1.4	0.72
St. Augustine	35	48.05	57.34	29.01	2.3	1.4	1.7	0.60
Tampa	40	51.49	89.86	32.25	2.8	1.8	1.6	0.64
Fort Myers	39	51.98	82.64	33.60	2.5	1.7	1.6	0.64
Alabama								
Mobile	37	61.80	91.18	39.50	2.3	1.5	1.6	0.63
Montgomery	36	51.16	69.85	37.00	1.9	1.4	1.4	0.72
Greensboro	35	49.86	68.98	35.67	1.9	1.4	1.4	0.71
Mississippi								
Vicksburg	54	59.07	84.22	37.21	2.3	1.6	1.4	0.71
Columbus	38	54.38	74.44	35.97	2.1	1.4	1.5	0.66
Tennessee								
Memphis	37	50.25	73.50	35.00	2.1	1.5	1.4	0.70
Murphy	28	59.67	84.80	45.64	1.9	1.4	1.3	0.77
Chattanooga	30	50.07	57.97	32.68	2.1	1.4	1.5	0.65
Knoxville	39	48.35	73.87	35.09	2.1	1.5	1.4	0.73
Clarkville	41	47.66	59.98	33.89	1.8	1.3	1.5	0.73
Kentucky								
Lexington	39	43.99	61.36	28.72	2.1	1.4	1.5	0.71
Louisville	36	44.04	56.50	29.25	1.9	1.4	1.5	0.66
Cairo	37	41.55	61.58	26.52	2.3	1.5	1.6	0.66
Ohio								
Cincinnati	74	40.91	65.18	17.99	3.8	1.6	2.1	0.43
Jacksonburg	39	39.19	50.95	22.65	2.3	1.3	1.8	0.57
Urbana	39	38.52	58.84	26.73	2.2	1.5	1.5	0.69
North Lewisburg	57	40.08	58.35	23.05	2.5	1.5	1.8	0.57
Portsmouth	76	40.50	57.59	24.30	2.4	1.4	1.8	0.60
Westerville	45	36.92	53.06	29.95	1.8	1.4	1.2	0.81
Marietta	87	42.20	61.84	26.00	2.4	1.5	1.7	0.61

RAINFALL FACTORS FOR UNITED STATES—Continued

Stations	Years	Mean	Max.	Min.	Max./Min.	Max./Mean	Mean/Min.	Min./Mean
Steubenville	39	41.15	57.78	28.02	2.0	1.4	1.5	0.68
Cleveland	38	34.90	47.82	24.54	1.9	1.4	1.4	0.70
Hudson	37	37.29	59.17	28.80	2.0	1.6	1.3	0.79
Sandusky	40	32.97	46.31	24.89	1.9	1.4	1.3	0.75
Toledo	47	32.57	45.91	21.34	2.1	1.4	1.5	0.65
Wauseon	35	37.31	52.55	28.49	1.9	1.4	1.3	0.76
Michigan								
Alpena	36	32.79	45.61	21.59	2.1	1.4	1.5	0.65
Detroit	38	32.06	47.68	21.06	2.3	1.5	1.5	0.65
Lansing	45	30.99	48.36	19.30	2.5	1.6	1.6	0.62
Grand Rapids	34	34.85	52.14	26.18	2.1	1.5	1.5	0.62
Marquette	37	32.42	42.91	25.35	1.7	1.3	1.3	0.78
Grand Haven	35	33.78	47.89	24.02	1.8	1.4	1.4	0.71
Escanaba	34	31.14	43.83	22.21	2.0	1.4	1.4	0.71
Indiana								
Lafayette	29	38.29	46.18	27.07	1.7	1.2	1.4	0.70
Indianapolis	37	41.09	57.65	30.33	1.9	1.4	1.4	0.73
Illinois								
Cairo	37	41.61	61.58	26.52	2.3	1.5	1.6	0.63
Peoria	53	34.75	53.26	24.62	2.2	1.5	1.4	0.70
Davenport	37	32.63	46.82	17.33	2.7	1.4	1.9	0.53
Chicago	38	33.54	45.86	24.52	1.9	1.4	1.4	0.73
Wisconsin								
Beloit	42	32.71	46.64	18.86	2.5	1.4	1.7	0.59
Madison	41	31.25	52.91	13.49	3.9	1.7	2.3	0.43
Milwaukee	39	31.19	50.36	18.69	2.7	1.6	1.7	0.59
Manitowoc	47	30.18	40.51	20.16	2.0	1.3	1.5	0.66
La Crosse	37	31.31	44.74	17.37	2.6	1.3	1.8	0.55
Minnesota								
Duluth	38	29.82	45.28	19.70	2.3	1.5	1.7	0.58
St. Paul	72	27.80	49.69	14.86	3.3	1.8	1.9	0.53
Minneapolis	47	29.35	41.64	18.36	2.3	1.4	1.6	0.62
Red Wing	24	30.19	38.74	18.98	2.0	1.3	1.6	0.62
Morris	23	23.51	33.03	16.24	2.0	1.4	1.4	0.69
Iowa								
Keokuk	37	34.98	51.65	22.51	2.3	1.5	1.6	0.64
Dubuque	53	33.49	55.15	19.35	2.8	1.6	1.7	0.57
Monticello	51	34.89	52.30	18.57	2.8	1.5	1.9	0.53
Clinton	40	36.25	52.86	22.97	2.4	1.5	1.6	0.61
Davenport	37	32.64	46.82	17.33	2.7	1.4	1.9	0.50
Muscatine	40	37.79	49.51	28.53	1.7	1.3	1.3	0.75
Fort Madison	54	37.01	54.14	22.37	2.4	1.5	1.7	0.60
Logan	38	33.03	56.00	16.79	3.4	1.7	2.0	0.50
Missouri								
Oregon	53	36.43	50.74	23.12	2.2	1.4	1.6	0.63
St. Louis	72	40.14	68.83	23.28	2.4	1.7	1.7	0.57
Harrisonville	35	37.88	58.50	24.25	2.4	1.5	1.6	0.64
Kansas								
Independence	37	37.95	60.29	26.54	2.3	1.6	1.4	0.70
Dodge City	42	19.60	33.55	7.58	4.4	1.7	2.6	0.39
Wallace	39	16.66	34.00	7.45	4.6	2.0	2.2	0.52
Hays	51	22.89	35.40	11.80	3.0	1.5	1.9	0.52
Nebraska								
Fairburg	29	30.15	47.17	17.28	2.7	1.6	1.7	0.57
Omaha	41	30.46	48.92	17.82	2.7	1.6	1.7	0.58
North Platte	34	18.74	30.01	11.21	2.7	1.7	1.6	0.60
South Dakota								
Yankton	32	26.00	40.95	14.40	2.9	1.7	1.8	0.55
Fort. Meade	28	20.06	30.37	13.25	2.8	1.8	1.5	0.66
North Dakota								
Pembina	35	20.31	33.83	11.75	2.9	1.7	1.7	0.58
Bismarck	34	17.50	30.92	11.03	2.8	1.8	1.6	0.53
Louisiana								
Baton Rouge	40	58.93	77.30	39.95	1.8	1.2	1.5	0.67
New Orleans	63	55.63	85.73	31.07	2.8	1.5	1.8	0.55
Shreveport	38	45.45	66.60	23.10	2.9	1.5	2.0	0.51
Arkansas								
Hope	41	52.71	70.40	29.20	2.4	1.3	1.9	0.55
Helena	34	54.33	80.40	36.78	2.2	1.5	1.5	0.67
Texas								
Graham	22	28.41	43.61	16.48	2.6	1.5	1.7	0.58
Austin	50	33.96	53.99	18.34	2.9	1.6	1.8	0.55
Palestine	28	42.51	59.66	23.98	2.5	1.4	1.8	0.55
Galveston	28	46.31	56.87	23.71	2.8	1.4	2.0	0.51
Brownsville	37	26.89	60.06	12.31	4.9	2.2	2.2	0.46
Fort Ringgold	35	17.46	32.37	5.28	6.1	1.9	3.3	0.27
Ft. McIntosh	36	19.75	36.38	4.31	8.4	1.8	4.5	0.22
San Antonio	36	27.95	41.91	14.92	2.8	1.5	2.0	0.50
El Paso	40	9.66	21.81	2.22	9.8	2.4	4.0	0.25
Montana								
Miles City	31	12.75	22.75	9.07	2.5	1.8	1.4	0.71
Helena	27	13.21	19.63	6.71	2.9	1.5	2.0	0.50
Missoula	26	15.84	22.43	8.76	2.6	1.4	1.8	0.55
Havre	30	13.63	25.67	6.76	3.9	1.9	2.0	0.49
Glendive	18	15.48	22.71	9.90	2.3	1.5	1.6	0.63
Wyoming								
Yellowstone Park	21	18.80	28.43	8.85	3.2	1.5	2.2	0.46
Cheyenne	37	13.80	22.63	5.04	4.5	1.6	2.8	0.36
Ft. Washakie	19	12.23	25.24	5.22	4.9	2.1	2.4	0.42
Idaho								
Lewiston	28	14.68	21.71	9.73	2.2	1.5	1.5	0.66
Boise	20	13.27	22.95	7.90	2.9	1.7	1.7	0.59
Oklahoma								
Ft. Smith	24	41.52	64.63	22.27	2.9	1.6	1.9	0.52
Ft. Sill	35	30.85	50.08	16.07	3.1	1.6	1.9	0.52
Washington								
Spokane	28	17.89	25.99	12.02	2.1	1.5	1.5	0.67
Ft. Canby	31	64.05	91.74	39.93	2.3	1.4	1.6	0.62
Oregon								
Astoria	37	37.06	61.56	18.96	3.2	1.7	2.0	0.51
Ft. Ross	35	54.22	88.17	23.61	3.7	1.6	2.3	0.43
Salem	39	39.60	54.93	24.56	2.2	1.4	1.6	0.62
Portland	50	42.45	67.24	30.76	2.2	1.6	1.4	0.72
Baker City	19	12.88	18.23	8.55	2.1	1.4	1.5	0.66
California								
Woodland	37	18.30	46.26	6.70	6.3	1.6	4.1	0.21
Tehama	39	19.51	46.26	18.54	5.4	2.4	2.3	0.46
Truckee	39	27.52	42.47	6.70	6.3	1.6	4.1	0.21
Summit	39	48.07	76.54	18.85	4.1	1.6	2.6	0.39
Sacramento	60	19.40	34.92	8.44	4.1	1.8	2.3	0.45
Redding	35	38.71	62.26	14.56	4.3	1.6	2.7	0.38
Marysville	38	19.76	36.63	11.17	3.3	1.9	1.8	0.56
Nevada City	45	55.64	102.85	30.03	3.4	1.8	1.9	0.54
Georgetown	37	58.62	99.62	28.13	3.6	1.7	2.1	0.48
Folsom	38	24.51	46.07	8.52	5.4	1.9	2.9	0.35

RAINFALL FACTORS FOR UNITED STATES—Continued

Stations	Years	Mean	Max	Min	Max / Min	Max / Mean	Mean / Min	Min / Mean
Dairsville	38	17.26	31.74	6.97	4.5	1.8	2.5	0.40
Colfax	40	48.94	85.21	25.10	3.4	1.7	2.0	0.51
Cisco	40	52.02	95.03	21.83	4.3	1.8	2.4	0.42
Chico	39	23.39	37.27	12.31	3.0	1.6	1.9	0.53
Bowniarus	36	75.63	135.70	32.79	4.1	1.8	2.3	0.45
Boca	39	20.84	37.58	8.38	4.5	1.8	2.5	0.40
Auburn	39	35.13	60.63	18.07	3.4	1.7	1.9	0.52
Stockton	43	14.63	26.43	6.38	4.1	1.8	2.3	0.44
Santa Barbara	42	17.32	43.23	7.22	6.0	2.5	2.4	0.35
San Mateo	35	20.84	34.28	8.00	4.3	1.6	2.6	0.38
San Jose	36	15.35	25.55	6.63	3.9	1.7	2.3	0.43
San Francisco	60	22.83	38.82	9.31	4.2	1.7	2.5	0.41
San Luis Obispo	40	21.95	49.99	6.93	7.2	2.3	3.2	0.31
Salinas	36	14.16	24.53	6.81	3.6	1.7	2.1	0.48
Oakland	35	24.54	38.20	11.09	2.4	1.5	2.4	0.41
Modesto	38	10.47	16.96	4.19	4.0	1.6	2.5	0.40
Les Banos	36	7.99	16.68	4.57	3.6	2.1	1.8	0.57
Livermore	38	16.27	27.65	7.63	3.6	1.7	2.2	0.47
Hollister	35	12.87	26.05	6.10	4.3	2.0	2.2	0.47
Gilroy	35	19.81	39.67	7.98	4.9	2.0	2.5	0.40
San Diego	60	9.54	27.59	3.02	9.1	2.9	3.1	0.32
San Bernardino	38	15.92	37.08	5.46	6.8	2.3	2.9	0.34
Nevada								
Beowaine	36	6.48	14.92	2.10	7.1	2.3	3.1	0.32
Winnemucca	35	8.65	18.38	4.89	3.7	2.1	1.8	0.57
Utah								
Moab	20	8.36	14.52	4.32	3.9	1.7	1.9	0.52
Corrine	38	12.51	22.35	5.41	4.1	1.8	2.3	0.43
Ogden	37	14.74	23.11	6.54	3.5	1.6	2.3	0.44
Salt Lake City	35	16.33	23.64	10.94	2.2	1.4	1.5	0.67
Colorado								
Las Animas	39	11.65	16.97	3.78	4.5	1.4	3.1	0.32
Denver	37	14.05	20.12	8.48	2.4	1.4	1.7	0.60
San Luis	30	10.95	18.85	5.00	3.8	1.7	2.2	0.46
Arizona								
Tucson	40	11.66	24.17	5.26	4.6	2.1	2.2	0.45
Yuma	38	3.13	11.41	0.60	1.9	3.6	5.3	0.19
Prescott	35	17.40	39.47	10.02	3.9	2.3	1.7	0.58
New Mexico								
San Maraal	40	9.06	21.81	2.22	9.8	2.4	4.0	0.25
Massila Park	47	8.62	17.09	3.49	4.9	2.0	2.5	0.40
Ft. Wingate	42	14.53	25.95	6.37	4.1	1.8	2.3	0.44
Sante Fe	50	14.72	25.80	7.75	3.8	1.7	1.9	0.53
Ft. Union	43	18.49	39.17	6.35	4.1	1.6	2.9	0.34

states. In the other Western states this tendency is not so marked, and the factor is less than in the above-mentioned regions. Along the Mexican border there are several districts where the factor is only 0.2 or 0.3.

A comparison of this map with a map of mean annual rainfall shows, generally speaking, that in the regions of moderate or heavy precipitation the minimum-mean factor is greater than in the regions of low precipitation, and when the average rainfall is below approximately 20 in. the minimum-mean factor, in general, decreases as the average rainfall decreases. It is also evident that the factor is greater on the North Atlantic coast, particularly in New England, than elsewhere. There are several stations in the Pacific Coast states, in eastern California particularly, where the normal precipitation is about the same as on the Atlantic Coast, but the minimum-mean factor is much less. It is of interest to note in this connection that the variations in monthly rainfall on the Pacific Coast are much more pronounced than on the Atlantic Coast.

Effect of Length of Record on Minimum-Mean

Our knowledge of the science of meteorology is not sufficiently advanced to state with accuracy the reasons why one year has less precipitation than another. The best that can be done is to say that an extremely low rainfall may occur once in a certain number of years—how many years no one can say exactly. Obviously, the longer the record the smaller will the minimum-mean factor be. The long records bear out this statement. For example, at Rochester, N. Y., Charlestown, S. C., Washington, D. C., and Boston, Mass., where the records are respectively 80, 115, 72 and 91 years in length, the factor is 0.5 for the first three and 0.6 for the last named city. To be sure there are a few other stations in eastern United States where the records are only about 40 years in length that have minimum-mean factors of from 0.4 to 0.5. However, for these stations it would undoubtedly be true that in a period of 100 years the factor would be no less, because the year of lowest rainfall in a 100-year period might occur in the first five years of the record or it might occur in the last five years.

Usefulness of the Minimum-Mean Factor

In hydraulic investigations it is often the case that only short records of precipitation are available, and it is desirable to know what the minimum rainfall for a long period of years would be. If the minimum-mean factor for the locality is known, at least an approximate estimate of the minimum rainfall can be made. For example, at Albany, N. Y., there is a long record of precipitation, 84 years in length. At Hoosick Falls, to the southeast of Albany, the record is only six years in length. The record at Hoosick Falls extends from 1904 to 1909, during which time the average precipitation was 38.16 in. The average rainfall for the 84-year record at Albany is 38.39 in., but from 1904 to 1909 it was only 30.13 in., considerably lower than the normal. It is undoubtedly true that Hoosick Falls also had a rainfall much below the average during this period. To estimate the least rainfall for this station the following calculations may be made:

$$\textit{For 50 years } \tfrac{2}{3}\left(\frac{38.39}{30.13} \times 38.16\right) = 32.42 \textit{ in.}$$

$$\textit{For 100 years } \tfrac{1}{2}\left(\frac{38.39}{30.13} \times 38.16\right) = 24.31 \textit{ in.}$$

The above relations may be taken as a formula as follows:

$$X = M\,\frac{(LS)}{L'}$$

in which

X = Required minimum rainfall;
M = Minimum-mean factor for the district;
L = Mean rainfall for entire period at adjacent station which has a long record;
L' = Mean rainfall at adjacent station during the period in which the records were taken at the station which has a short record;
S = The mean rainfall at the station which has a short record.

By averaging the results obtained in the above way from a number of adjacent stations with long records, a safe estimate of the minimum rainfall can be made. The results obtained from using the factors ½ for 110 years and ⅔ for 50 years are conservative for eastern United States. These factors, however, should not be used for the western part of the country, for they are shown to be much less west of the Mississippi River.

It is to be expected that the average rainfall for an entire river drainage basin will not vary to such an extent as the rainfall for an individual station. Therefore, the minimum rainfall will more nearly approach the mean, so that the minimum-mean factor will be greater for a large area than at a single station. However, it is not safe to assume, especially where the climatic conditions are much the same over the entire watershed, that the minimum-mean factor should be more than 10% greater for an entire river drainage basin than at an individual station. While this statement may seem too conservative, the writer has found it to be the case in working out the factor for a number of widely separated large areas, the data for which are not given on account of lack of space.

Coreless Hydraulic-Fill Dam Built of Lava

By J. W. Swaren*

A coreless earth dam 1550 ft. long has been built by the Lewiston-Sweetwater Irrigating Co., in western Idaho, where the only available soil was lava ash and weathered lava. In spite of the nature of the material the maximum seepage is small.

The dam at present is 442 ft. wide on the base, 54 ft. high and 1550 ft. long. It is designed for an ultimate height of 85 ft. and a crest length of 3600 ft. Its present storage capacity is 2466 acre-feet; when completed, its capacity will be 6682 acre-feet. The upstream face has a slope of 1 on 3, while a slope of 1 on 2 is given the downstream face. At the point selected for the dam, the profile of the ground surface is rather uneven; upstream a fill of 9 ft. was necessary to bring the prism to the grade of the axis. A puddle trench, 8 ft. deep and 10 ft. wide, is placed along the axis.

Construction began in 1906. The surface of the ground was stripped and scarified. During the spring months a dike along the upstream toe (*A*, Fig. 1) was raised about 34 ft. The earth was placed in 6-in. layers by wheeled scrapers, sprinkled, rolled and harrowed. During the summer months a similiar dike (*B*) was built along the

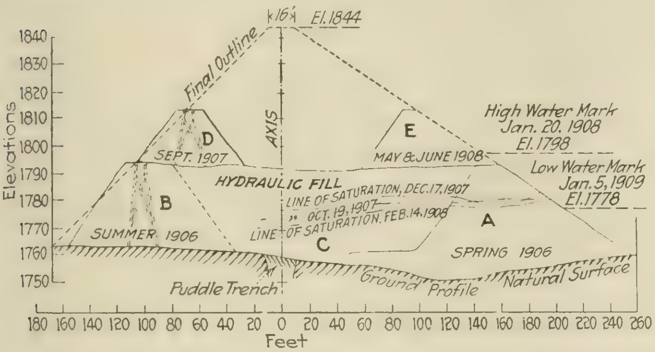


FIG. 1. SECTION THROUGH LEWISTON-SWEETWATER LAVA DAM

downstream toe. The material for this dike was dumped dry from a trestle. So far as possible, all material composing the dam prism has been taken from borrow pits inside the flooded area, in order to increase storage capacity. Puddle clay for sealing the toe was obtained from a small deposit near the north end.

While the dike along the downstream toe was being built, water for the irrigation season of 1906 was stored behind the upstream dike. During the fall and winter of 1906 and the spring of 1907 the prism (*C*) between these dikes was filled by a unique combination of water settling and dump-cars. Water from the main canal was conducted into the area between the upstream and the downstream dikes. Earth was dumped into this water from cars running on rails laid along the top of the upstream dike, the water in the pond between the dikes settling the earth firmly and at minimum cost.

Water was stored and used for the irrigation season of 1907; and no additional work was done on the dam until September, when a second dike (*D*) was made on the downstream toe, with its base on top of the fill already in place. The material was dumped from cars on a trestle and settled by water from a 1½-in. hose.

*R. R. 2, Box R, Hayward, Calif.

FIG. 2. UPSTREAM AND DOWNSTREAM SLOPES

Additional land coming under irrigation, a larger storage was required. Financial conditions were unsettled at this time, and completion of the dam was out of the question. As the cheapest method of securing the desired capacity, a dike (*E*) was built on the upstream toe, with its base on the fill already in place. This was built by dumping from cars on a track laid along the center of the fill; the earth was moved both ways by scrapers. This work was stopped at El. 1814, providing for a total storage of 2466 acre-feet, with water level at El. 1810.

A concrete tube laid in rock excavation under the dam serves as an outlet. When the concrete was poured, particular attention was given to filling and carefully tamping all crevices in the rock. This outlet, from the point where it pierces the upstream face, at El. 1760, to the axis of the dam, is 4 ft. in diameter. At this point it widens to 8 ft. in diameter and continues to the downstream face, where a wood-stave pipe line, the main conduit of the distribution system, joins.

At the point where the outlet conduit increases in diameter a concrete shaft rises to the top of the dam. Two 36-in. gate valves, with steel stems extending up the shaft, are placed at this point. A steel sluice gate, which is used in normal operation, is set where the outlet passes through the upstream face. A steel tower supports the operating mechanism for this gate.

The inner face of the dam displays the effect of wave action, each day's draw-down showing clearly in a little bench washed out of the fill. As the line of saturation is rather flat and shifts rapidly, the maximum storage is not made until the last snow run-off. The first irrigation period, closely following, draws down the water level well below the saturation line. During high water in the reservoir, careful watch is kept on a line of test pits along the downstream toe of the dike.

Drainage at the downstream toe is carefully developed, and no waterlogging of the prism occurs. At high-water period this drainage is 0.033 sec.-ft. After the close of the irrigating season, with the water at the level of the outlet pipe, drainage is only 1 cu.ft. in 29 min., indicating that in spite of unfavorable materials an excellent bond has been made between the dam and the original ground.

This dam was designed by L. G. Carpenter, of Fort Collins, Colo., who also supervised construction.

Impact Tests on Brick Paving Slabs Variously Construed

SYNOPSIS—Views of different paving engineers as to meaning of impact tests on sand-cushion and monolithic brick pavements.

The publication of the discussion of Prevost Hubbard, of the United States Office of Public Roads and Rural Engineering, on "Impact Test of the Efficacy of Sand Cushions in Brick Pavements," in *Engineering News*, Feb. 1, has brought out a number of interesting views as to what the tests actually showed. These opinions are published herewith, together with a further discussion by Mr. Hubbard.

Discussion by Paul E. Green,* of Chicago

In reading Mr. Hubbard's paper and the editorial referring to it, the writer is impressed with the fact that apparently neither your editorial nor Mr. Hubbard's report shows a clear understanding of the problem. Emphasis has been placed on non-essentials. The essentials are ignored.

If we go back to the fundamentals of road construction, there can be little question that, if a thoroughly dried, well-drained earth road is considered, it will stand practically any load that can be put upon it, with the possible exception of the enormous trucks that were referred to in your editorial; and even then it is probable that the thoroughly dried dirt road could be successfully used as a roadway. Fundamentally, the earth road is the foundation upon which all pavements are laid. Therefore, it is the earth that really withstands the load. Any pavement or surfacing that is placed thereon is for the purpose of securing a surface that is not affected by moisture, is smooth and dustless. The thickness of a wearing surface, provided it is a rigid wearing surface, has nothing to do with the problem.

The problem, therefore, as stated before, is to provide a rigid, or nearly so, wearing surface, which will shed water and will prevent moisture from getting into the subgrade. No construction yet attempted has achieved this result perfectly, but it is the belief that in the case of brick-surfaced roads the monolithic type approaches this ideal.

For many years brick highways and streets have been built with the sand cushion. There have been a good many failures of these roads and pavements, and engineers have been trying to find out the reason. Observation has generally shown that the brick had expanded; in nearly all cases of failure, before the failure occurred, the surface had heaved. A space was thus formed between the bottom of the brick and the sand cushion.

This heaving, accompanied by cracking, etc., and a consequent release of the pressure on the sand cushion, caused the sand to shift; water entered, part of the sand was pumped up through the cracks to the surface of the pavement and blown away, and other portions of the cushion were forced into heaps, from 2 to 4 in. in depth, with corresponding bare spaces of concrete at some points. The pavement became noisy. As soon as the bond of the surface was destroyed, the pavement could not go back to its original position and consequently within a comparatively short time would be utterly destroyed. It was because of this trouble that the monolithic type was developed.

If the surface of the pavement can be kept in its original position, a very large amount of the trouble will be permanently eliminated. This result is believed to have been obtained in the monolithic type. Experience extending over several years with various pavements, as for instance wood block, has shown that there is sufficient bond between the green mortar and the blocks (including the interstices) practically to eliminate separate movement between the base and the wearing surface.

It is possible to get a much smoother job with a mortar than it is with a plain sand bed. Experience is unanimous on this point. If, therefore, we take this point into account, with the demonstrated result as shown by Mr. Hubbard's experiments that the grout between the brick is much less liable to crack and spall in the monolithic type than in the sand-cushion type, do not the correlated facts go far toward proving the contention of those who are impressed with the desirable features of the monolithic construction?

It is the writer's belief that the greater smoothness of the mortar-joint pavement and the bond of the block to the base (even though this bond is limited) much more than compensate for the slight loss in cushioning effect of the sand, especially as the report shows very clearly that the strength of the monolithic type was fully equal to that of the sand-cushion type.

*Consulting Engineer.

Discussion by W. W. Horner,* of St. Louis

The writer has been much interested in Prevost Hubbard's tests of impact on brick pavement, but is inclined to draw somewhat different conclusions from their analysis to those indicated in your editorial of Feb. 1. It seems to the writer that your editorial comments do not sufficiently emphasize the difference between the characteristics of the individual brick and those of the brick pavement as a whole.

In either type of pavement the resistance of the brick to impact is about double the resistance of the individual brick standing alone. The resistance of the sand-cushion pavement as a pavement, however, is less than that of the single brick, for the grout joints failed at a blow of 40 cm. Further blows apparently drove the center brick into the sand, and the sand bed undoubtedly absorbed much of the impact thereafter. In this way the life of the individual brick under the hammer was prolonged at the expense of the pavement as a pavement.

The resistance of the monolithic pavement as a whole was about double that of the individual brick, and this resistance is evidently accomplished by the rigid restraint that the surrounding brick and mortar bed exercised on the unit under impact. The important point is that the monolithic pavement remains efficient and uninjured practically to the last blow.

*Engineer of Sewerage and Paving Design, City of St. Louis.

To summarize, the sand-cushion pavement does not secure the full value of the constituent material; the monolithic structure is twice as good as the brick it is made of. Experience has shown that the pavement in which the grout joints are broken is not only subject to very rapid further deterioration, but is almost immediately an unsatisfactory pavement. Very generally in a brick pavement with broken grout and invariably under heavy traffic, the sand cushion will be displaced, resulting in the formation of transverse ridges or waves and occasionally even an appreciable rut. In fact, the pavement with broken grout joints is, in this respect, inferior to a pavement that is merely sand filled. It will of course continue to carry traffic, but its rating by the common factors used to compare it with the ideal pavement will be enormously reduced.

I believe Mr. Hubbard's test should be analyzed on this basis; and if so considered, then the monolithic brick pavement will carry twice as heavy traffic as the sand-cushion pavement.

We know already that modern traffic produces sufficient impact to crack the grout joints of the sand-cushion type. We do not know that it produces an impact twice as great as necessary to do this. If it does, Mr. Hubbard's test indicates that the monolithic also will fail. If it does not, the monolithic type will never fail, but will wear out and will remain comparatively smooth and solid to the end. Even in the absence of further tests we can be certain that the monolithic pavement will provide for a heavier traffic than did the old type.

In the tests the monolithic type finally failed as a whole; that is, it cracked through the base. This is in accord with theory. If a test could be arranged on somewhat larger specimens and if the specimens of both types should be tested on a firm soil instead of upon the anvil base, is it not reasonable to expect that the monolithic type would show even greater superiority than has been indicated? Is it not possible that under these conditions, which are actually service conditions, the brick will be worn to pieces on the surface before the base cracks?

Discussion by Will P. Blair,* of Cleveland

The recent discussion that has taken place involving the relative influence of impact upon a brick pavement constructed in monolithic form and one constructed on a sand cushion does not seem to the writer to meet the real or practical question. The inquiry should be as to which practice is better. It will not do to draw any definite conclusion from a half-dozen laboratory tests.

The one reason for engineers clinging so long to the use of the sand cushion was the belief that the resiliency afforded was necessary for the protection of the brick against shock and impact, but its necessity, doubted by some for several years, is not now considered necessary at all by those who have studied and observed the behavior of both types.

The only reason for the use of the sand cushion under stone or brick was to prevent their breaking and shattering, but is now well established, not only by laboratory experiments, but by hundreds of pavements, that the sand cushion is not necessary. In none can shock effects be observed. We therefore have hundreds and thousands of practical experiments that afford proof that the sand cushion is not necessary for the protection of brick in its actual use in pavements.

But granting a resilient relief is one of benefit, the same relief is given the pavement as a whole by the earth under the monolithic slab as by the sand cushion under the brick. It does not matter from a practical standpoint what is the measure of relief in the use of a sand cushion supporting a 4-in. slab or with the earth supporting an 8- or 10-in. slab. It is the greatest advantage in the practical use and economy of materials that is wanted.

That brick and stone pavements constructed upon 1½- and 2-in. sand beds have remained in good condition while subject to excessive wear for many years is sufficient proof that such pavements are economical and well worth all they cost. However, it is true that it has been very difficult to induce those building pavements to properly compress and compact the sand cushion; and where this neglect has occurred, bad results have followed. This practice therefore involves a hazard which, if possible to avoid, is but an act of wisdom. At the very worst the monolithic pavements afford results equal to the best of any other method, and the hazard in construction is eliminated.

*Secretary, National Paving Brick Manufacturers' Association.

Concluding Note by Prevost Hubbard

The writer wishes to note that the conclusions given in his report were based only upon the experimental data submitted, as with one exception he did not feel warranted at this stage of the investigation in undertaking to point out just how the information gained could be most advantageously applied in practice.

Mr. Horner's discussion of the inherent defects of the sand-cushion type of pavement impresses the writer as having been well thought out and ably presented. He can readily see how upon the basis of Mr. Horner's argument some such comparison of the monolithic and sand cushion types might be drawn. He is inclined to regret, however, that Mr. Horner apparently overlooked the significance of what to the writer appears to be the most illuminating result of the tests. This is the fact that failure of the foundation occurred along with the brick in the monolithic type, while in the sand-cushion type a foundation of the same thickness (6 in.) remained intact under equally severe tests.

The only conclusion in the original report specifically applied to engineering practice was based upon this foundation weakness of the monolithic type, which seems to throw into question the practice recommended by some engineers of employing a foundation of less thickness than with the sand-cushion type.

One of the principal advantages frequently claimed for the monolithic type is the reduction in construction cost due to the possibility of decreasing the foundation thickness. In view of the test results, however, it would certainly appear that engineers should go very slowly in economizing on the foundation where the monolithic type is employed.

More than this, there are other features of monolithic construction which are of great merit. It may be well to mention two very important ones, namely: (1) The minimizing of noise, which places brick pavements so constructed in the very highest class in this respect. (2) A pavement is secured which affords a surface unsur-

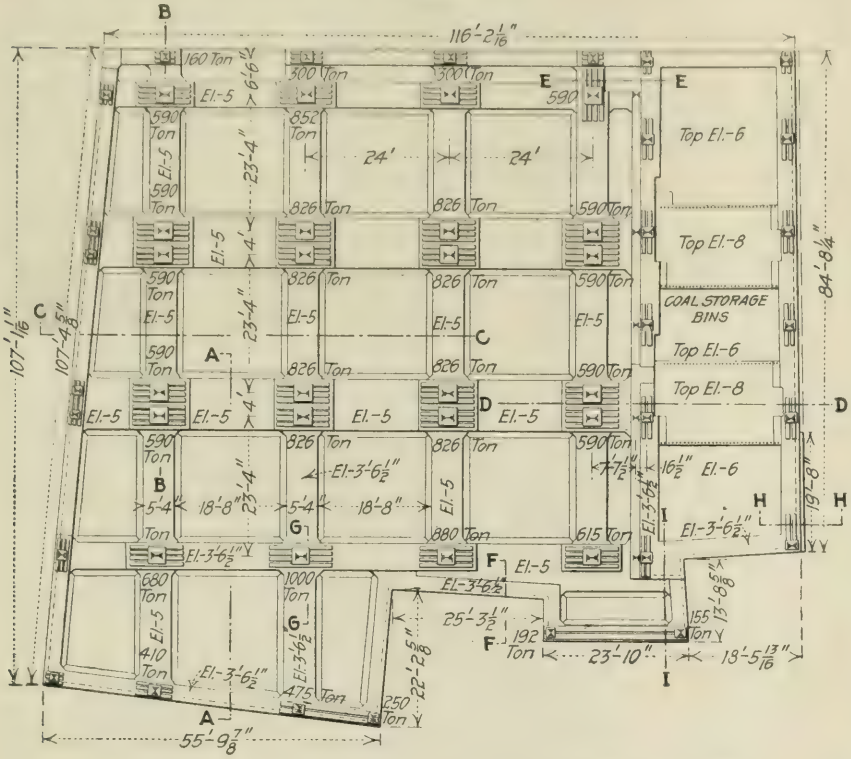
passed for ease of cleaning. If, therefore, the construction of a brick pavement in monolithic form gives to the public the most and best for its money, is not that after all the end of the argument?

Cumulative experience has caused the use of a thin foundation to be largely abandoned, where the sand cushion is used, and until a great deal of positive experimental data is obtained, it would seem unwise to adopt a thin foundation for the monolithic type.

The writer plans to continue tests on sections of brick pavements and hopes that engineers will feel free to offer suggestions as to how the methods may be improved so as to make the results of practical value.

Concrete Mat on Confined Sand Supports Boiler Plant

To found a large boiler house on wet-flowing sand in the downtown district of New York City, a thick reinforced-concrete mat was designed with the sand underneath confined by a ring of interlocking steel sheet-piling. At this location, hardpan sloped rapidly eastward; and core borings showed that, although good bearing could be obtained on the west side of the lot, piers would have to be put down 70 ft. on the east side, if hardpan were to be reached. This would have called for compressed air and would have been very expensive. The alternative was a spread footing, and the one designed by Daniel E. Moran, consulting engineer for the New York Steam Co., and constructed by The Foundation Co. is quite remarkable. The plant divides naturally, as regards loads, into boiler house and coal bunkers, and the two elements were treated as separate buildings. They adjoin, but do not connect, being separated by a paper slip-joint. The site is 107 x 116 ft., the bunker house being the full width of the building by about 26 ft. wide. The first operation was to put down a steel sheetpile cofferdam to a depth of 24 ft. below curb all around the lot. A steam shovel inside the sheetpiling excavated to grade. After the pit had been cleaned up by hand, a 6-in. carpet of cinder concrete was laid to serve as a working floor and to keep the bottom clean and undisturbed. On this surface the forms were erected and the reinforcing steel was laid, all the rods being placed before concreting was started. The design of the mat is given



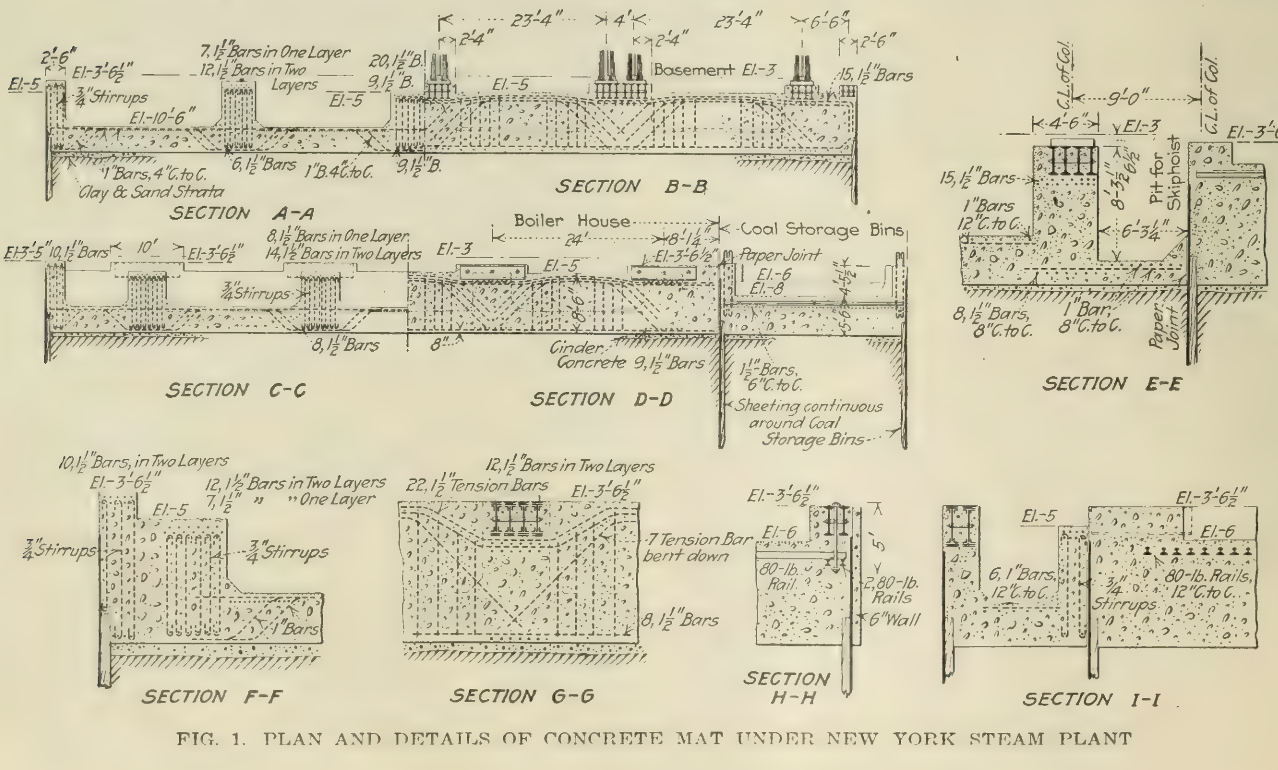


FIG. 1. PLAN AND DETAILS OF CONCRETE MAT UNDER NEW YORK STEAM PLANT

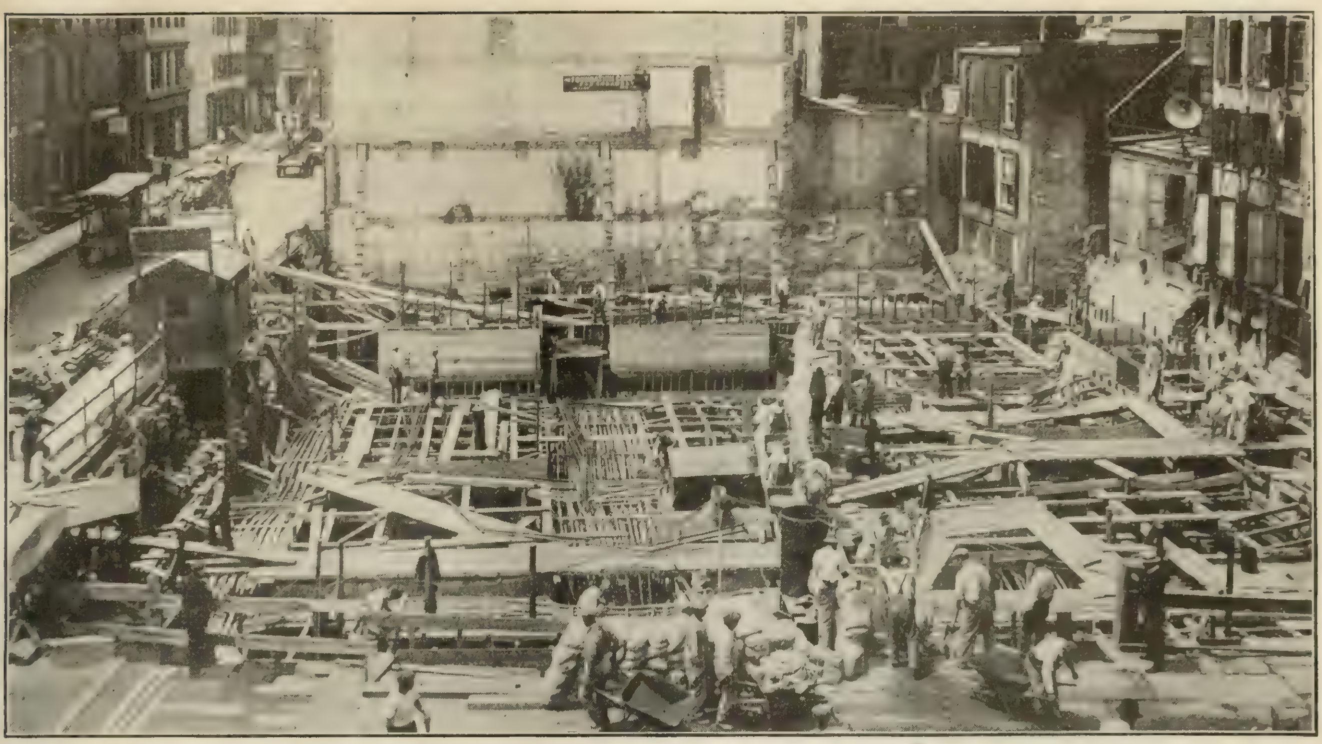


FIG. 2. SHOWING HEAVY REINFORCEMENT IN PLACE IN STEAM-PLANT FOUNDATION

in Fig. 1. The slab is 36 in. thick, with its bottom 13½ ft. below curb. It is reinforced with 1-in. bars, 4 in. apart and placed both ways. Every other bar is bent for shear. All the reinforcement bars are square twisted. On top of the slab, but monolithic with it, is the concrete-girder system. The largest girder, 8 ft. 8 in. wide by 8 ft. 6 in. deep from bottom of slab, is reinforced with twenty-nine 1½-in. bars and is provided with shear rods.

The girder forms were built on stilts set in wood sockets or post holes, as illustrated in Fig. 3. The concreting was carried on as nearly continuously as possible. There were no horizontal joints, and where a

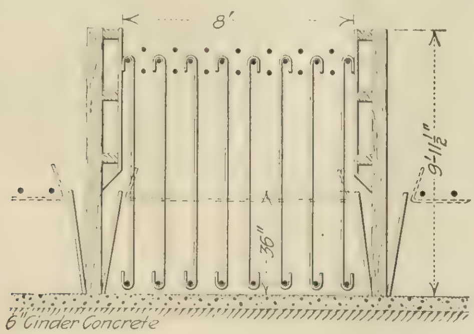


FIG. 3. SCHEME OF SUPPORTING SLAB FORMS AND REINFORCEMENT

vertical joint was necessary, it was formed at column points. After concreting, the wood sockets were removed and the reinforcing rods were bent down and the post holes concreted.

Before the forms were erected, the slab steel was laid on the ground; and as soon as the forms were in place, this steel was lifted to its final position and wired to the girder forms. Special precautions were taken that the steel remain absolutely in place. Fig. 2 is an excellent view of the reinforcement and forms in place and concreting in progress.

The concrete mixer was installed off the lot, and the concrete was transported in buggies. This hand placing of concrete was very satisfactory. In spite of the close spacing of the reinforcing, there was no special difficulty in placing the concrete, which was soft and had aggregate of less than 1 in.

The bunker house, having capacity for 5000 tons of coal and 1000 tons of ashes, is carried on a 7½-ft. slab reinforced with 80-lb. rails, spaced 12 in. c. to c. and put in with spacers to hold them in position. The joint between the two buildings was formed as follows: Two coats of hot coal-tar pitch were applied to the surface of the concrete wall first built, then three plies of heavy-weight tar paper were put on and covered with a coat of hot pitch.

The load of the boiler room averages 2.6 tons per sq.ft. of the entire foundation. For the coal-plant mat the load is 5.4 tons. The main center panels have twin columns, each bearing 826 tons. The columns of the main bays are spaced 24 ft. apart in one direction and 27 ft. 4 in. in the other. The wall loading per column varies from 225 to 475 tons and averages 300 tons. The loading around the bunker walls is 48 tons per lin.ft.

Prize Designs for Workmen's Dwellings Announced—Prizes of \$300 to \$100 offered by the National Americanization Committee about a year ago, in connection with the movement for better housing of immigrants newly arrived in America, have now been awarded. The object of the competition was to produce good and economical plans for low-cost dwellings to be used as standard types in directing the attention of manufacturers, property owners and municipalities to the importance of industrial housing. The competition was divided into four classes, with two prizes of \$300 and \$200 in each case. First prize for a four-room single-family house was awarded William Lyon Summerville and Atwell J. King. Murphy & Dana were awarded first prize for a five-room single-family double house, while Messrs. Summerville and King received first prize for a single-family house to have four lodgers. Under the fourth classification, calling for a boarding house and carrying no prizes, Messrs. Summerville and King, John A. Thompson and Ernest F. Lewis, Henry E. Hill and Edwin F. Dodge received special mention.

Delivering Mixed Aggregate Along the 85-Mile Winnipeg Aqueduct

By Douglas L. McLean*

The concrete aqueduct section of the new Winnipeg water-supply is 85 miles long, so that the problem of concrete manufacture was somewhat complicated. One important factor in the successful construction was the use of a central plant where concrete aggregate was mixed in proper proportions and from which the mixed aggregate was transported to the 14 mixing plants located at set intervals along the line.

As the route of the pipe line passed through unsettled country, it was necessary to build a standard-gage railway for transportation of materials entering into the construction of the aqueduct. This railway runs parallel to the center line of the aqueduct and at a distance therefrom of 110 ft. In order to secure a regular supply of material to the various contractors' camps and because

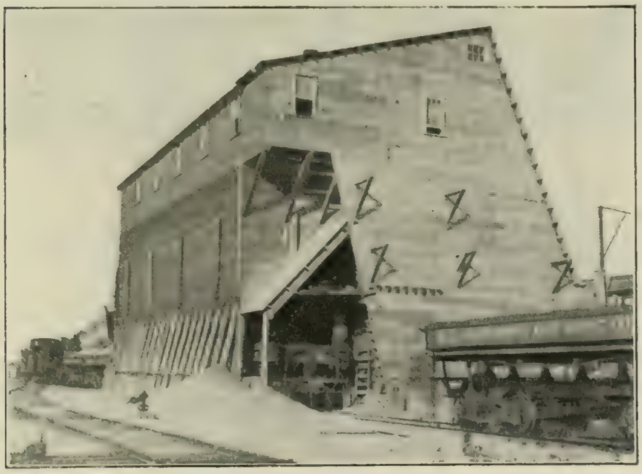


FIG. 1. LOADING MIXED AGGREGATE AT MIXING PLANT

the railway that was the only practical means of transport for materials entering into the aqueduct construction was to be operated by the district forces, it was early decided that the supplying of sand and gravel for concrete could be most economically handled in conjunction with the other work being done by the district. This conclusion led to studies of the cheapest method of hauling and handling such materials with standard-gage railway equipment. It was shown that by the use of mixed aggregate a saving could be made of one-eighth the number of cars required for the delivery of sand and gravel separately. Further investigations showed other advantages, which resulted in the decision to supply graded aggregate from a central mixing plant.

Source of Aggregate Supply

A gravel deposit at Mile 31 on the railway was chosen as the source of supply for this aggregate. Test pits showed it to contain a large supply of gravel with a well-graded sand, considerable quantities of oversize, and at one end of the pit a deposit of very fine sand. This pit as opened up has a 25-ft. face with about 2 ft. of stripping on top. A 15-ton Browning locomotive crane equipped with a $1\frac{1}{2}$-cu.yd. bucket and a 42-ft. boom are used for stripping, loading fine sand, spotting cars, moving track and as a spare for excavating. A No. 14 Bucyrus dragline with a 2-cu.yd. bucket and a 60-ft. boom is used for excavating the gravel. This machine operating from the top of the pit has a great advantage over a steam shovel in that it is able to leave clay or

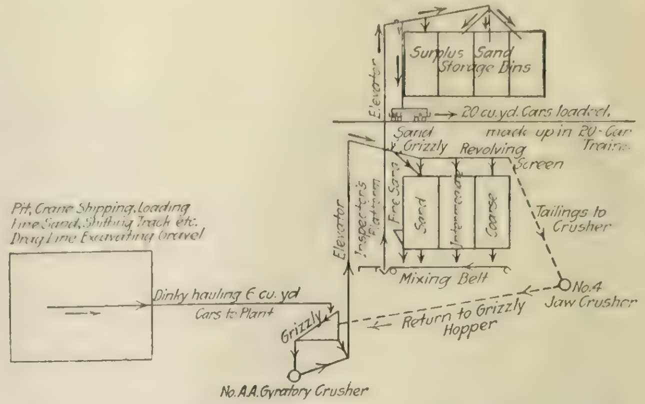


FIG. 2. DIAGRAM SHOWING OPERATIONS AT MIXING PLANT

material high in sand right in the pit and also because the cars serving it do not require to be operated up and down a steep grade into the pit bottom, as would be required for steam-shovel operations.

The operations for excavation at the pit to final loading into the dump-cars for transportation on the district railway are shown diagrammatically by Fig. 2. The materials excavated by the dragline are loaded into 6-yd. Western dump-cars and hauled by a 19-ton steam dinkey locomotive to the screening plant. Here the materials are dumped upon an inclined grizzly with bars spaced to give 3-in. clear opening. The oversize is fed by hand from this grizzly into a No. 4-A gyratory crusher and thence, after crushing, to the elevator, which carries the gravel from the grizzly hopper up to the screens. A sand grizzly 4 ft. long with $\frac{3}{8}$-in. clear openings is located in the chute leading to the revolving screen. This screen, which revolves at 18 r.p.m., is 48 in. in diameter and is divided into three sections: The first is 10 ft. long with $\frac{3}{8}$ x 1-in. long slots; the second is 4 ft. long with $1\frac{1}{2}$-in. diameter round holes; and the third is 4 ft. long with $2\frac{1}{4}$-in. diameter round holes. Oversize from this screen is tailed to a No. 4 champion jaw crusher and thence elevated back to the hopper under the main grizzly.

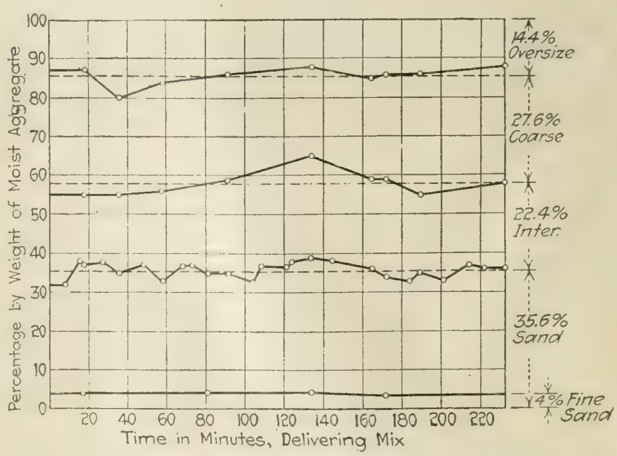


FIG. 3. VARIATION IN AGGREGATE AT SCREENING PLANT DURING TYPICAL RUN

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The materials from the screens pass into three bins—respectively sand, intermediate and coarse stones. From these bins the material is drawn through hoppers and chutes with hand regulating gates to a mixing belt. The mixing of the aggregate is done by three laborers under the direction of a skilled inspector. First, the material from the coarse bins comes upon the mixing belt, which travels at the rate of 300 ft. per min.; then the material from the intermediate bin comes on top of the coarse material; and last, the sand comes on top of the other two materials.

In certain sections of the pit the sand is deficient in fine grains, and here the fine sand is added by means of the crane. For the day shift, loaded trains of 6-yd. dump-cars are run back under the crane, which adds fine sand to each carload. For the night shift, the crane loads up a number of carloads of fine sand, which are dumped where the dragline is excavating. The dragline runner then digs this fine sand in with the material he is loading. Thus the inspector has to see that the sand has sufficient fine material. If it is too coarse, he can

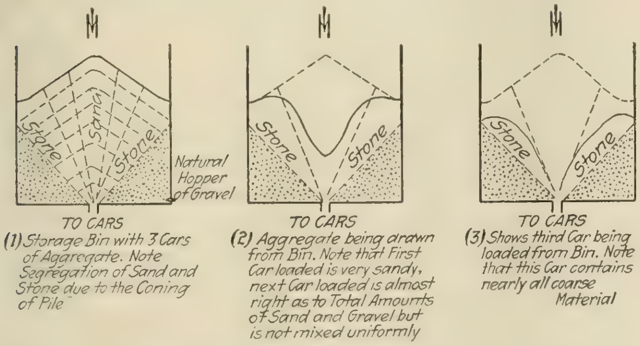


FIG. 4. DIAGRAM SHOWING HOW STORAGE IN BIN AND LOADING SEPARATES AGGREGATE

run it off to the surplus-sand storage bins. In order to oversee the mixing, the inspector's platform is located at the delivery end of the mixing belt, so that he can direct the laborers as to the quantities required for each chute.

Variation in the Material

For sampling, a V-shaped trough is used, which catches the material coming off the mixing belt. The accumulated material is then piled on a sheet of iron that also serves as the floor of the platform. It is mixed by shovel, and then a 20-lb. sample is taken for mechanical analysis. One sample is taken for each car shipped, and control samples are taken whenever the inspector notices any change in the mixture. The percentage of fine sand and moisture is checked from 1-lb. samples. The daily-report form is made out by the inspector, and a copy of it is sent into the head office (Fig. 6). The materials entering into aggregate are classified as follows:

Fine sand	Material passing No. 100 sieve; square opening
Sand	Material passing ⅛-in. square opening
Intermediate	Material passing ½-in. square opening and held on ⅛-in. square opening
Coarse	Material passing 1½-in. square opening and held on ½-in. square opening
Oversize	Material passing 2¼-in. diameter round hole and held on 1½-in. square opening

The mixture for aggregate (determined by extensive laboratory research) is kept within the following limits:

Fine sand	10 to 20% of the dry weight of sand
Sand	32 to 40% of the dry weight of aggregate with 35% as objective
Sand and intermediate	Not more than 70% by dry weight of aggregate
Oversize	Not more than 25% by dry weight of aggregate

FIG. 5. AGGREGATE TRAIN EN ROUTE ON WINNIPEG AQUEDUCT

Fig. 3 shows the range of the variations in a typical day's run when the aggregate was mixed at the rate of 90 cu.yd. per hour. The mixed aggregate is elevated and discharged direct into dump-cars of 20 cu.yd. capacity, which are moved along by a car puller and switched by dinkey to the storage track, ready to be made up into trains of 18 to 20 cars. A number of methods were tried to provide storage of the mixed aggregate in bins, but this could not be accomplished at reasonable cost. The coming action of gravel in the bins unmixes the aggregate as it is deposited in storage, and it is further segregated when the material is drawn into cars from the bottom of the storage bins. This is shown diagrammatically in Fig. 4.

Transporting the Mixed Aggregate

The maximum output of the season of 1915, in one day, two 10-hour shifts, was 1357 cu.yd. of mixed aggregate and 160 yd. of surplus sand. In 1915 this plant supplied 58,000 cu.yd. of mixed aggregate and 30,000 cu.yd. of other materials, and in 1916 some 130,000 cu.yd. of aggregate and 12,000 cu.yd. of other material.

For transporting the aggregate the district standard-gage railway is used. As required from day to day, trains of 10 to 20 cars (20 cu.yd., air dump) are made up and hauled out to distribute the aggregate to the site of its use (Fig. 5). In transport there is no segregation of the mixed aggregate, though a shrinkage of from 3 to 10% occurs. At each site of work, plank platforms are provided by the contractors for the reception of the aggregate (see Fig. 8). In dumping upon the platform, there is a tendency toward slight segregation, as the coarse material rolls away from the railway track. Such slight segregation is overcome by the contractors' men in loading the material for the mixer; they dig swaths in the pile of aggregate at right angles to the railway track.

The aggregate is sold to the contractor at 75c. per cu.yd. for sand and 75c. per cu.yd. of gravel delivered from cars at the site of work. The aggregate is measured at the plant. The contractor is allowed 10% shrinkage in transit, and he pays on the basis of the yardage of separated materials. Two years' experience on this work

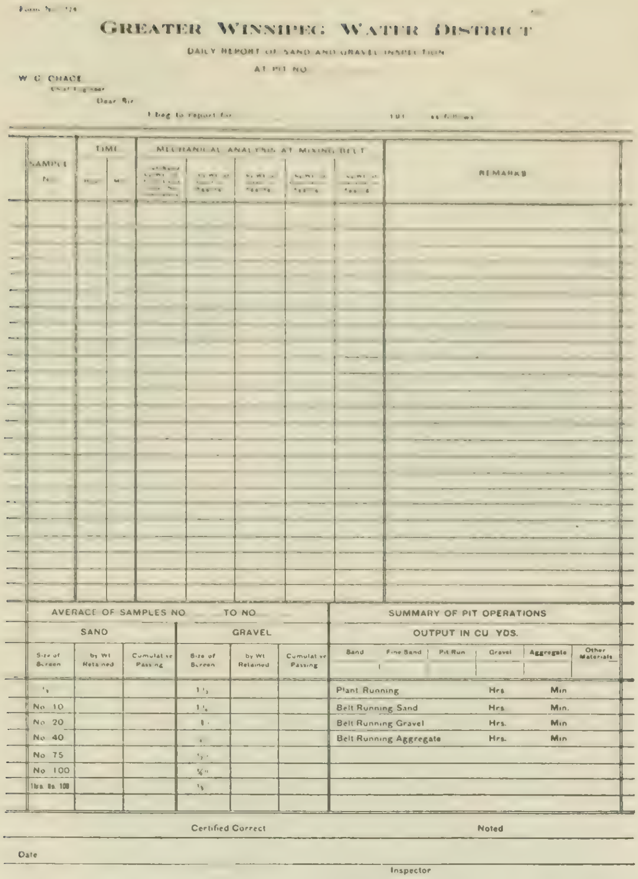


FIG. 6. FACSIMILE OF DAILY AGGREGATE REPORT

with graded aggregate has shown it to give the following results:

1. A dense impermeable concrete, uniform at all working points.

2. A saving in cement quantities. The mixture at present used is three bags (87½ lb. gross each) of portland cement to 18 cu.ft. of loose moist aggregate. This gives some 1.15 bbl. (376 lb.) of cement to each cubic yard of set concrete. This may be compared with 1.57 bbl. of cement per cubic yard for 1 : 2 : 4 mixtures commonly specified and used for supposedly water-tight work. The saving in using the Water District mixture over an ordinary 1 : 2 : 4 mixture, with cement at $2.75 per bbl. of 350 lb. delivered on the site of the work, will amount to $350,000 on 100,000 cu.yd. of concrete, the approximate quantity required for this water-supply project.

3. At the pit only is it necessary to have inspectors trained in the proper proportioning of the materials.

4. Proper proportioning of all ingredients of the aggregate necessary for the desired water-tight and economical concrete is possible only at the pit. The cost of mixing is 1c. per cu.yd. of aggregate.

5. A saving of one-eighth the number of cars that would be required for the delivery of sand and gravel separately. This item amounts to about $10,000.

6. The mixed aggregate is easier and cheaper for the contractor to handle than are separated materials.

James H. Fuertes, New York, is Consulting Engineer of the Greater Winnipeg Water Commission; W. G. Chace is Chief Engineer; M. V. Sauer is Engineer of Design and Deputy to the Chief Engineer. The writer is assistant to the Chief Engineer with special charge of work relating to test and inspection of cement and aggregate.

FIG. 7. 20-CU.YD. CAR DUMPING AGGREGATE ON CONTRACTOR'S PLATFORM

How Price of Railway Supplies Has Risen

New data on the increased price of railway supplies were given by George S. Patterson, general solicitor of the Pennsylvania Railroad Co., when he appeared on Mar. 7, before the Pennsylvania Public Service Commission in connection with the proposed compromise of the anthracite freight-rate case, which has been under litigation in the Dauphin County court. (The railroad company is willing to accept compromised rates on anthracite coal to end the litigation and out of deference to the state commission; but it is unwilling to accept the rates fixed by the state commission, in view of the old rates being accepted by the Interstate Commerce Commission and because of the great rise in cost of supplies.) The Pennsylvania figures are summarized below:

PRICE INCREASES OF RAILWAY EQUIPMENT AND SUPPLIES; PENNSYLVANIA R.R.

	1914	1917	% Increase
L 1 S locomotives	$28,500	$39,500	38.6
Standard steel passenger car	$15,000	$20,000	33.0
Standard steel gondola car	$1,184 (1915)	$2,569	117.0
Couplers, per pair	$16.60	$30.30	82.6
Axles, per lb	1.5c.	4.1c.	173.4
Bridge steel, per lb.	1.83c.	4.71c.	157.5
Steel tires, per lb	3.25	6.50	100.0
Rolled wheels, each	$15.50	$20.50	32.2
Steel billets, per ton	$25 to $31	$77 to $79	178.5
Plates and shapes, per lb	1.05 to 1.10c.	4 to 4.5c.	295.0
Bar iron, per lb	1.20 to 1.30c.	3c.	140.0
Steel castings, per lb	2.60 to 6.10c.	5.50 to 11c.	89.5

The Pennsylvania Lines East in 1916 purchased about $70,000,000 worth of materials and supplies, exclusive of fuel and equipment. On the basis of 1917 prices these purchases would cost $78,000,000.

Frequent changes in labor (30,000 new men being employed during the year) have reduced the efficiency of the labor above the rates of pay, which have been advanced to meet industrial competition.

In 1916 the Pennsylvania Lines East consumed nearly 12,000,000 tons of bituminous coal, which was secured at $1.25 per ton. This coal is now selling for immediate delivery at the mines at $5 to $6.50 per ton, and contracts for the year commencing Apr. 1 are being made at $3.50 per ton. It is expected that the cost of fuel to the railroad will increase by some $8,000,000.

In ten years the taxes have risen from 8c. to 14c. per $1 of net operating revenue. The increase in 1916 was due to the increase in the Federal income tax.

Spring Frictions Will Hold Quebec Span Against Drag of Braked Trains

By A. J. Meyers*

SYNOPSIS—The long suspended span of the Quebec Bridge, 640 ft. between pins, will be subject to a sudden movement, over the 17-in. leeway provided, when brakes are applied to a high-speed train passing over it. In order to restrain this influence a traction brake is provided at end of cantilever arms.

On account of the unusually large span of the Quebec Bridge, 1800 ft. between main piers, an exceptionally large amount of motion due to changes of temperature and stress-deformation of the truss members had to be provided for.

The 640-ft. suspended span is hung from the ends of the cantilever arms by a double chain of eye-bars at each of the four corners of the span. The total amount of expansion provided for at each of these points is about 17 in. In order to prevent any sudden movement of this span, due to the application of the brakes to a train moving over it at a high rate of speed, it was thought advisable to apply a restraining influence to the maximum amount of traction force that could be applied at any one time—amounting to about 500,000 lb. at each of the four corners.

*Chief Draftsman, Board of Engineers, Quebec Bridge, Montreal, P. Q.

To accomplish this result it was necessary to design an instrument which, while allowing the 17 in. of motion, would be able to apply a resisting force to the traction at any point of this motion.

For this purpose what may be called a laminated friction brake will be used. This brake, as shown in Fig. 2, is made up of a series of plates that slide between each other and are kept in contact by a set of car springs under a constant compression. Every alternate plate is fixed by a pin at one end to the horizontal piece of chord at the end of the cantilever arm and has a slotted hole at the other end, to allow the necessary motion on the pin, which fixes the remaining sliding plates to the suspended span. These remaining plates are slotted in a similar manner, so as to allow the same amount of motion on the pin connecting the first-mentioned plates to the cantilever arm.

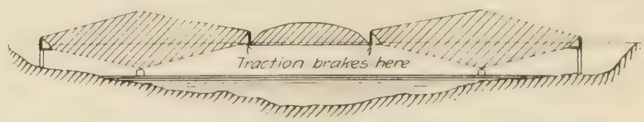


FIG. 1. DIAGRAM OF QUEBEC BRIDGE TO SHOW POSITION OF BRAKES

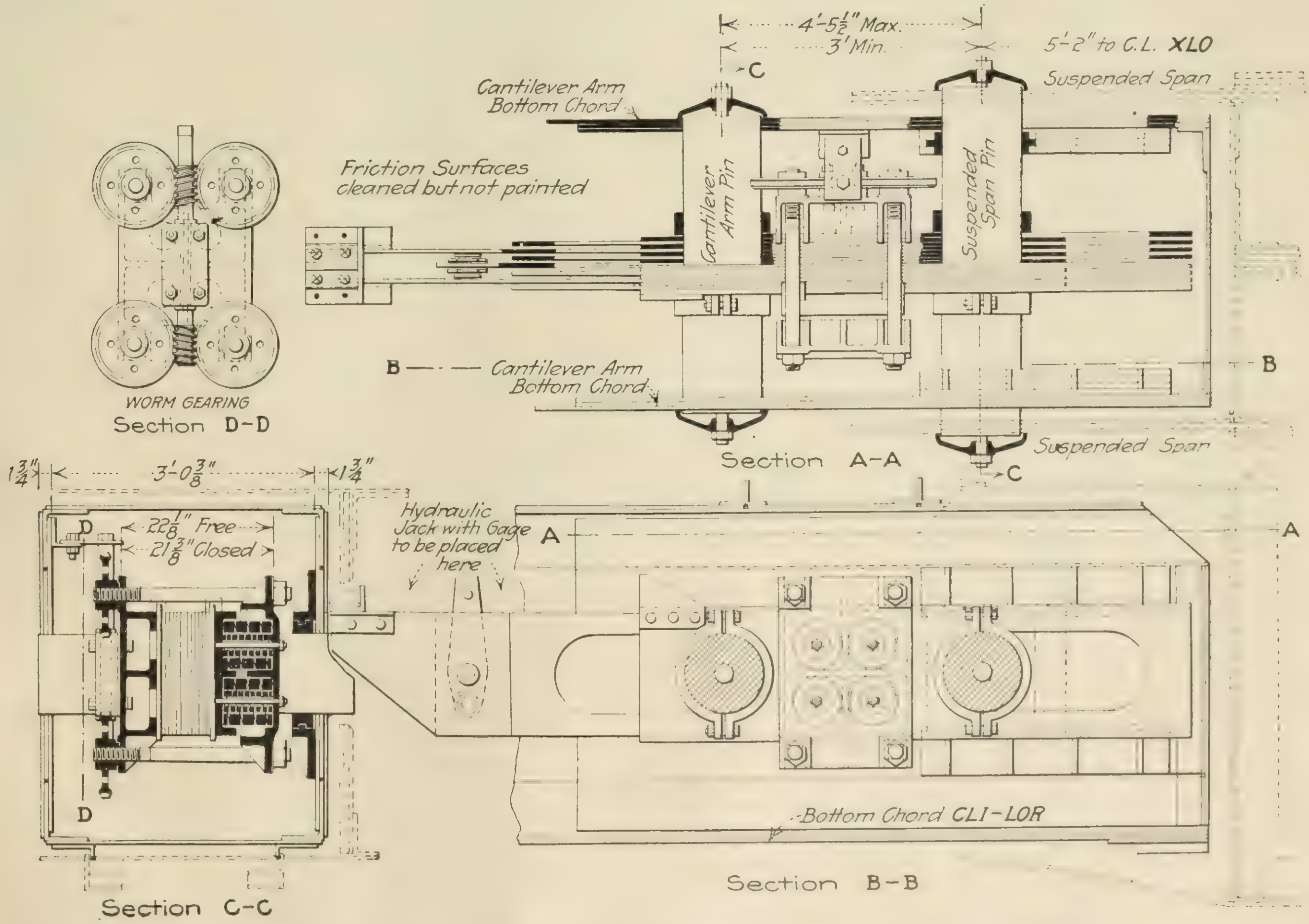


FIG. 2. TRACTION BRAKE FOR SUSPENDED SPAN OF QUEBEC BRIDGE

Each brake is designed for a working resistance, to begin with, of 250,000 lb. This force is developed by the friction between the 14 contact surfaces. Between each of the surfaces there must be developed a frictional resistance of $250{,}000 \times {}^{1}/_{14} = 18{,}000$ lb. If we figure on a minimum coefficient of friction of 15% this will require that the plates be pressed together by a force of $18{,}000 \times {}^{100}/_{15} = 120{,}000$ lb. To obtain a force of this amount, four double helical springs, each double spring having a capacity when closed of 38,000 lb., are used for each brake. The outer coil is made up of $1\frac{9}{16}$ in. square and the inner coil of ¾ in. square steel. The springs have a height, closed, of 6¼ in., and open of 7 in.

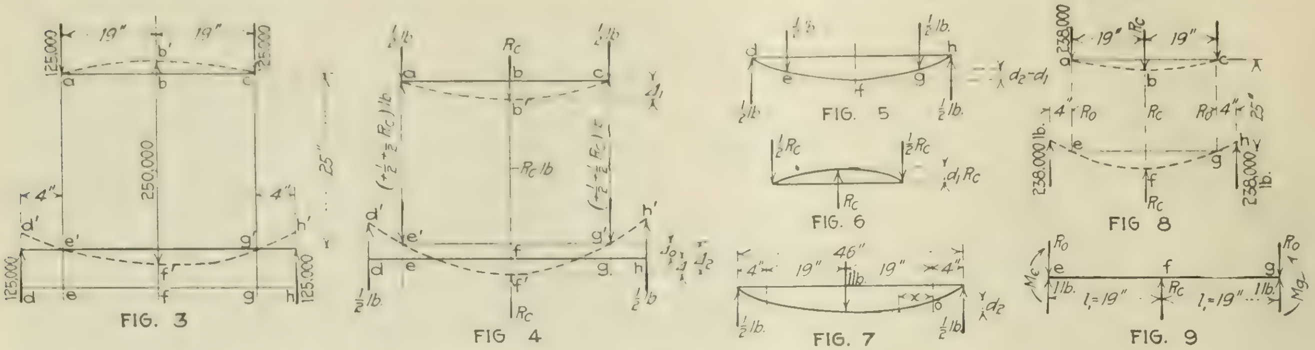
The middle sliding plate is detailed so that the amount of frictional resistance can be ascertained by applying to it a small hydraulic jack with a gage. The springs will be compressed by means of the worm gearing shown in the illustrations, until this middle plate develops a resistance to motion, as measured by the gage, of 36,000 lb., since the plate has two contact surfaces.

This brake force of 250,000 lb. is constantly acting and the brake in constant motion, due to changing temperature and deformation of the trusses under moving loads. The contact surfaces will therefore wear to some extent, and the springs will also take a certain amount of permanent set under the constant compression acting. The effect will be to reduce partly the resistance of the brake, but the amount of this resistance can be tested from time to time by means of the jack and gage mentioned, and the springs tightened up if necessary by means of the worm gearing.

The total longitudinal forces passing through this joint amount to 726,000 lb. at each corner of one end of the suspended span. When it happens that the wind and traction forces act together, the span will move under their influence, with each brake resisting to the extent of 250,000 lb. until the pin, connecting the suspended span to the brake, comes to a bearing at the end of the slotted hole in the chord of the cantilever arm, when the greater part of this 726,000 lb. will be transmitted directly through this pin to the chords.

To determine the maximum bending in this pin was an interesting problem, since it is not known what part of the force of 726,000 lb. passes through the brake and what part goes directly through the pin to the chords of the cantilever arm. The solution of this problem is given herewith:

In Fig. 3 the lines dd' and hh' are center lines of ribs from the suspended span; the lines ae and cg are center lines of ribs of the cantilever-arm chord; the line bf is the center line of the brake; the lines abc and dfh are center lines of the pins before any load comes on the brake; the curved lines $ab'c$ and $d'f'h'$ are center lines of the pins after the force of 250,000 lb. has been applied and the brake has slipped under the action of this force until the pin just touches at the points e' and g'. As the load comes on the pin dfh, the pin bends, but no sliding of the brake results until this load has reached the resisting capacity of the brake, or 250,000 lb. The brake then slides, and the sliding continues until the pin dfh comes to a bearing at the points e' and g', when the total force of 726,000 lb. is immediately resisted. No further sliding of the brake takes place, as the pin now becomes continuous over three supports, a negative reaction from the load of 726,000 — 250,000 = 476,000 lb. resulting at the point f', which reduces the initial brake stress of 250,000 lb. The problem is to find out the amount of this reduction in stress.



FIGS. 3 TO 9. DIAGRAMS FOR DETERMINATION OF BRAKE-PIN STRESS

In the following analysis let

δ_1 = Deflection of the pin abc under 1-lb. load at b on a span ac equal to 38 in.;

δ_c = Elastic deformation of the brake bf under stress of 1 lb.;

δ_0 = Elastic deformation of ribs ae or cg of the cantilever arm under stress of 1 lb.;

δ_2 = Deflection on a length eg, equal to 38 in. of the pin dfh under a load of 1 lb. at f, the pin having a span dh equal to 46 in.

Further, as shown in Fig. 4, let a load of ½ lb. be applied at each of the points d and h. The pins deform from the positions abc and dfh, before applying this load, to the positions $ab'c$ and $d'f'h'$ after this load is resisted. The stress in the brake bf is $-R_c$ pounds, and that in the cantilever ribs ae or cg is $\frac{1}{2} + \frac{1}{2}R_c$ pounds.

Let

Δ_c = Elastic deformation of the brake under stress $R_c = \delta_c R_c$ inches;

Δ_1 = Deflections of the pin abc under load R_c pounds $= \delta_1 R_c$ inches;

Δ = Deflection of the point f' from its unstressed position f;

Δ_0 = Elastic deformation of cantilever ribs ae or cg under stress of $\frac{1}{2} + \frac{1}{2}R_c$ pounds $= \delta_0 (\frac{1}{2} + \frac{1}{2}R_c)$ inches;

Δ_2 = Deflection of the point g' from the point f'.

The deflection δ_2 is equal to that resulting from a loading as shown in Fig. 5, plus a deflection, equal to δ_1, from a 1-lb. load applied at the center of a span eg.

Δ_2 is caused by a loading as shown in Fig. 5, giving a deflection of $\delta_2 - \delta_1$, minus the deflection, from a loading as shown in Fig. 6, equal to $\delta_1 R_c$. Therefore

$$\Delta_2 = \delta_2 - \delta_1 - \delta_1 R_c$$

From Fig. 4 it is seen that

$$\Delta = \Delta_2 - \Delta_0$$

and

$$\Delta = \Delta_1 + \Delta_c$$

Therefore,

$$\Delta_1 + \Delta_c = \Delta_2 - \Delta_0$$

or substituting the values given previously,

$$\delta_1 R_c + \delta_c R_c = \delta_2 - \delta_1 - \delta_1 R_c - \tfrac{1}{2}\delta_0 - \tfrac{1}{2}\delta_0 R_c$$

$$R_c = \frac{\delta_2 - \delta_1 - \frac{1}{2}\delta_0}{2\delta_1 + \delta_c + \frac{1}{2}\delta_0} \qquad (1)$$

The sectional area of the cantilever ribs *ae* and *cg* is equal to 94 sq.in., and that of the brake *bf* is 151 sq.in. Then

$$\delta_1 = \frac{Wl^3}{48EI} = 5.35 \times 10^{-8}\ in.$$

$$\delta_c = \frac{Wl}{AE} = 0.55 \times 10^{-8}\ in.$$

$$\delta_0 = \frac{Wl}{AE} = 0.90 \times 10^{-8}\ in.$$

where

I = Moment of inertia;
l = Length;
A = Area of the member considered;
E = Modulus of elasticity of the material 29,500,000 lb. per sq.in.;
W = 1 lb.

$$\delta_2 = \int_0^{19} \frac{Mxdx}{EI} \qquad \text{(See Fig. 7)}$$

Taking the origin of coördination at O, $M = 2 + \frac{1}{2}x$. Then

$$\delta_2 = \frac{1}{EI}\int_0^{19''} 2xdx + \tfrac{1}{2}x^2dx$$

$$= \frac{1}{EI}\left[x^2 + \tfrac{1}{6}x^3\right]_0^{19''}$$

$$= 7.05 \times 10^{-8}\ in.$$

Substituting these values in equation (1),

$$R_c = \frac{(7.05 - 5.35 - 0.45) \times 10^{-8}}{(10.7 + 0.55 + 0.45) \times 10^{-8}} = 0.105\ lb.$$

That is, if when the pin *dfh* comes to a bearing at the points *e'* and *g'*, a ½-lb. additional load is applied at each of the points *d* and *h*, the reduction in the brake load of 250,000 lb. amounts to 0.105 lb. When the full additional load of 726,000 — 250,000 = 476,000 lb. is applied, the reduction in the brake load is 476,000 × 0.105 = 50,000 lb.; and the final brake stress is then 250,000 — 50,000 = 200,000 lb. compression.

The change in stress in the brake from 250,000 lb., after the pin has come to a bearing at the points *e'* and *g'* and the total force of 726,000 lb. is resisted, can also be found by using the theory of the continuous beam with yielding supports. This change in stress is due to the application of the force of 726,000 — 250,000 lb. = 476,000 lb. The loads and unknown reactions for this case are as shown in Fig. 8.

Let the influence calculations for R_c be first made for a 1-lb. load at each of the points *d* and *h*. The formula (see "Modern Framed Structures," by Johnson. Bryan and Turneaure, Part II, page 19) for the continuous beam with yielding supports, for this case, reduces to (see Fig. 9)

$$M_e l_1 + 4M_f l_1 + M_g l_1 = 12EI\left(\frac{h_1 - h_2}{l_1}\right) \qquad (6)$$

$$M_e = M_g = 4\ in.\text{-}lb.$$

$$M_f = 4 + 19 - 19R_o = 23 - 19R_o$$

$$2R_o - R_c = 2$$

$$R_c = 2(R_o - 1)$$

Yielding of support *e* or *g* equals

$$h_1 = +R_o \times 0.90 \times 10^{-8}$$

Yielding of support *f* equals

$$h_2 = -R_c\,(0.55 \times 10^{-8} + 5.35 \times 10^{-8})$$

Substituting these values in equation (6), it becomes

$$76\,(2 + 23 - 19R_o) = \frac{12 \times 29.5 \times 10^6 \times 720}{19}$$

$$\times\,(R_o \times 0.90 \times 10^{-8} + 11.8 \times 10^{-8} R_o - 11.8 \times 10^{-8})$$

from which R_o = 1.105 lb.; R_c = 2(1.105 — 1) = 0.21 lb. for 1 lb. at each of the points *d* and *h*. R_c for 238,000 lb. at each of the points *d* and *h* is equal to 238,000 × 0.21 = 50,000 lb.

This 50,000 lb. is the reduction in the primary brake stress of 250,000 lb., which takes place as soon as the total force of 726,000 lb. is resisted. The final brake stress is therefore 250,000 — 50,000 lb. = 200,000 lb., the same result as obtained in the first solution.

Must Keep Dwellings and Yards Clean Under Proposed Building Code

A state-wide building code for Pennsylvania, drawn up recently by a commission originally appointed by Governor Tener, contains among its radical provisions a clause making it incumbent on everybody to keep his house and yard clean. The clause is written into both the section referring to dwellings built after passage of the act ("hereafter erected") and all existing dwellings ("prior erected"). One of the two clauses reads:

a. It shall be the duty of each family occupying buildings of class IIIc [dwelling houses] hereafter erected to keep that portion of the building or the premises surrounding the building occupied by them exclusively free from all accumulation of dirt, filth, garbage or other refuse.

b. It shall be the duty of the owner to keep all portions of such buildings, or of the premises about such buildings that are occupied or used jointly by more than one family, free from all accumulation of dirt, filth, garbage or other refuse, and it shall be his duty further to report violations of this section to the local board of health or State Department of Health.

c. Any person who shall cause or permit any dirt, filth, garbage or other refuse to be cast into a yard, shaft, court or areaway, in or about any such building, or who shall commit any other nuisance in or about such building, shall be deemed guilty of violating the provisions of this section, and shall be subject to the penalties as herein in this act provided.

The act contains frequent references to the State Department of Health and to local boards of health and requires among other things approval of all plans for all buildings and various forms of permits to be obtained from these bodies in addition to those to be obtained from state or local building authorities. Adding to these duties of the boards of health the supervision over the cleanly condition of houses and yards is likely to put an unprecedented burden of work upon them.

Track Locations at Dayton Complicate a Bridge-Rolling Job

Bridge replacement by rolling the new bridge sidewise into place was so seriously complicated by track conditions in the case of the Dayton Union R.R. bridge that the work had to be done in two stages—rolling it half the distance to put the new track into service and several weeks later rolling it the rest of the way into final the width of the truss members separated adjoining tracks of the old and new structures to 17½ ft. Therefore, to permit operating after the first move, the approach tracks had to be spread 1½ ft. On account of switches, it was impossible, however, to shift the downstream track by more than 18 in. The upstream pair of girders of

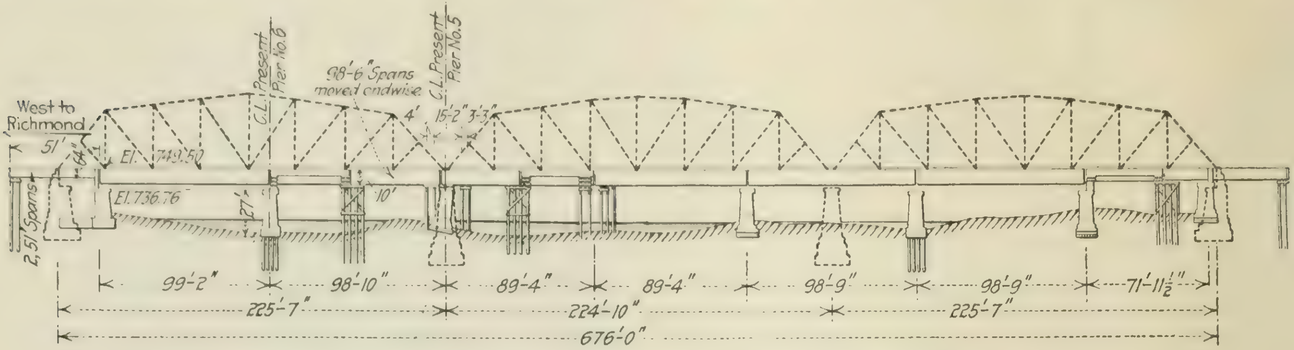


FIG. 1. THE NEW DAYTON UNION R.R. BRIDGE AND ITS PIER AND SPAN CONDITIONS

position. This bridge, crossing the Great Miami River at Dayton, Ohio, and used by several railways, was washed out by the great 1913 flood, was restored in temporary fashion during the busy weeks that followed and has now finally been replaced in lasting manner by a bridge designed to be proof against future flood effects (note comparative foundations in Fig. 1.) The necessity of maintaining traffic and yet of building the bridge on the old alignment dictated the rolling-in method. Attendant circumstances led to the extra complication of the two-stage move.

The old bridge, as restored, rested in part on pile piers and cribs. On this account it was not practicable to roll both old and new bridges, rolling the old one out as the new one came in—the quickest method and one involving no track changes. The old bridge had to be torn out before the new one could be rolled over. Yet, as the Dayton terminal yard begins at the east end of the bridge and buildings border the railway property at the west end, the running tracks could not be deflected over to reach both tracks of the new bridge in its first, or erection, position. One track could be reached by running a spur track from within the yard.

At first this set of conditions appeared to mean single-track operation for some weeks. However, the old bridge being a deck-girder double-track structure, in effect a double bridge, the one-track half adjacent to the new bridge could be torn out, leaving the other old track in service, and the new bridge rolled over halfway, so that both of the new tracks could be put under traffic; then the rest of the old bridge removed and the rolling completed. This proved to be the logical procedure and was adopted.

How Track Conditions Hampered the Work

Conditions were not quite as simple as just indicated. Looking west, endwise at both bridges, their relative positions are sketched in the upper sketch of Fig. 2. The track spacing is 13 ft. on centers in both bridges, but the old bridge could be moved outward 2 ft. before reaching the limit of the piers. If this were done, the downstream track would need only 2 ft. shift, and by crowding the clearance somewhat it was possible to reduce this amount to 18 in., solving the difficulty. The extra operation of moving the upstream half of the old bridge was therefore of necessity used.

The set of diagrams in Fig. 2 shows the resulting relationships of tracks. In *A* the new bridge is in its erected position, and both old tracks are untouched and

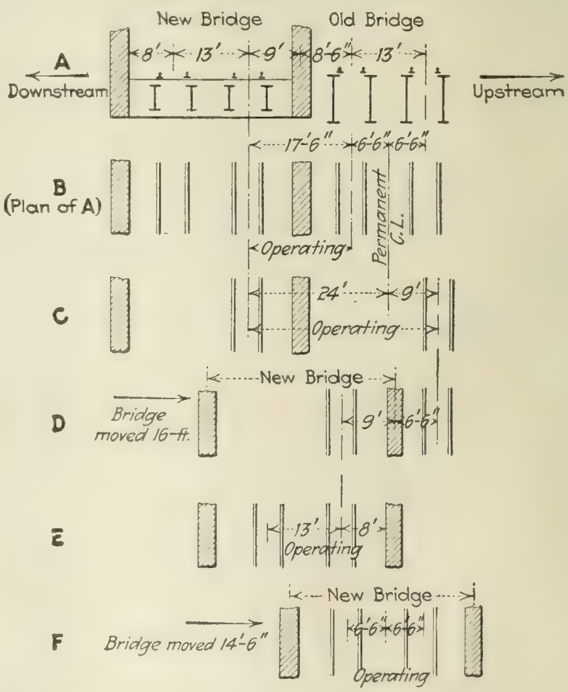


FIG. 2. RELATION OF BRIDGES TO TRACK AT EAST END OF CROSSING

carrying traffic, until traffic is shifted to the tracks indicated in *B* in order to permit the 2-ft. shift of the upstream old girders, whereupon these latter again take

traffic (*C*) for removal of the downstream girders. The result of the first move *D*, indicates the clearances then prevailing; the remaining old track is being removed, and then the second or final move is made, as at *F*.

The program of operations indicated by these sketches was carried out successfully, no hitch of any sort occurring. Erection of the new bridge on its trestle support was completed in November, having been begun about June 1, 1916. Only one span could be erected at a time, as the Miami Conservancy District objected to placing falsework in more than one opening. So soon as one span was swung, the falsework was shifted to the next span. Fig. 3 shows the erection falsework as well as the end supports or rolling falsework.

When traffic could be turned on one track of the new bridge, the upstream old track was taken out of service and its girders were moved 2 ft. upstream. Then traffic was again put on this track, abandoning the downstream old track, and the latter was lifted out span by span by the contractor's derrick car (50 tons' capacity at 50-ft. reach) operating in the same track and taking its load away endwise. This left space for moving the new bridge over. This move was made Dec. 4, in about two minutes' actual moving time. Putting both new tracks in service and taking out the rest of the old bridge occupied some three weeks. On Dec. 27, the second move to final position was made. Within the following week the spans were jacked up, the roller tracks removed and the shoes placed; after clearing away, the contractor was off the job by Jan. 20, 1917.

As the new bridge had to carry trains while still resting on falsework, it was necessary to provide means for distributing the reaction along the length of the end support, since the load was too great for concentrating on a small number of the falsework bents. This was accomplished by blocking at four points under each end of each span, the blocking being placed in such order that two sets of blocking carried the dead-load, and the other two shared in carrying live-load.

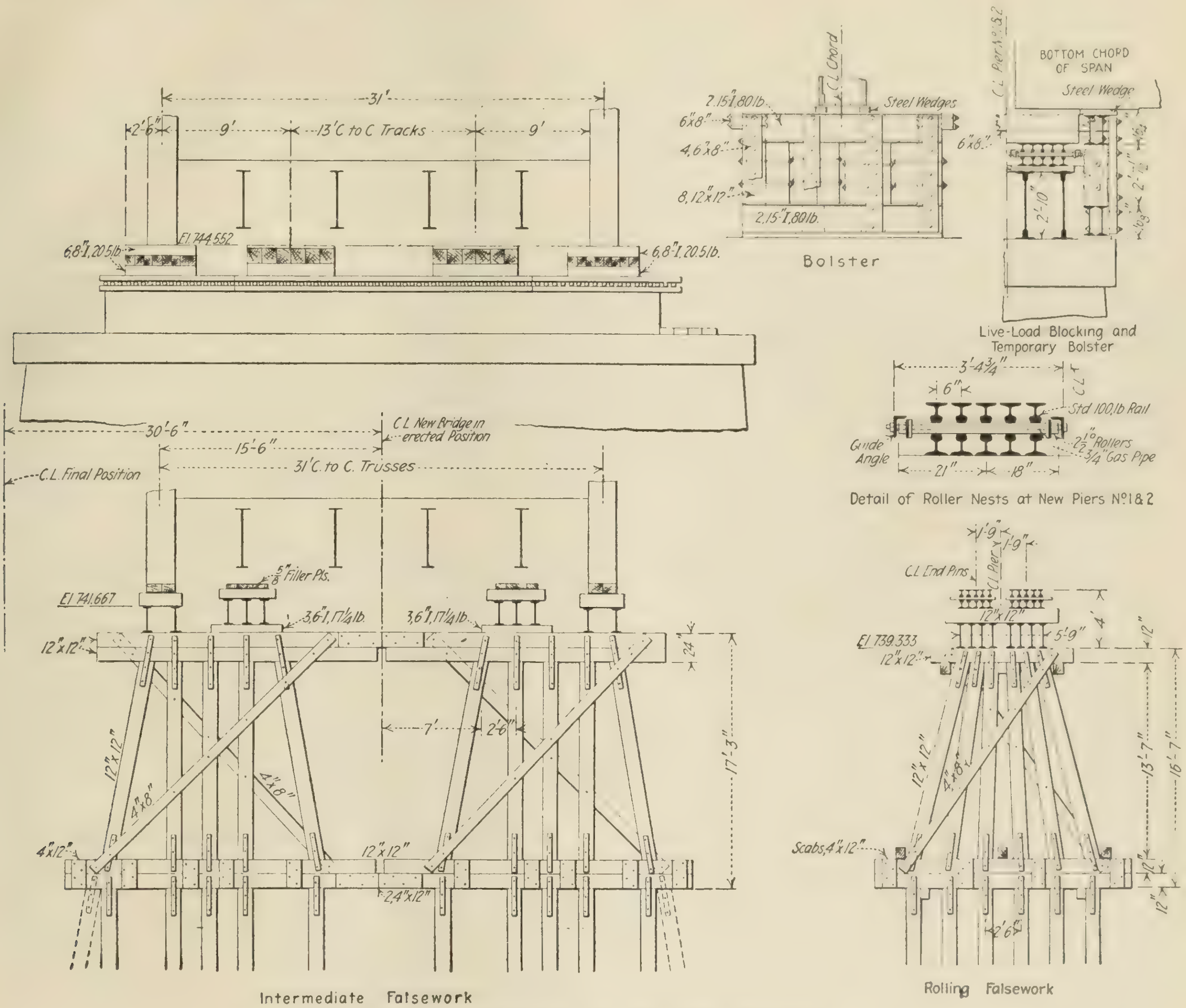


FIG. 3. ERECTION AND ROLLING DETAILS

Live-Load Blocking and Roller Track

The end floor-beam of a span was originally set on two groups of blocking, approximately under the tracks; and when the span was swung, the entire dead-load reaction of the end came on this blocking. Then two other sets of blocking were inserted under the truss ends, driven in tight so as to be in good bearing, but to carry no material part of the dead-load. Being directly under the trusses, however, these outer blocks would carry practically all the live-load.

This quadruple blocking proved entirely successful. No disarrangement of the blocks occurred during moving, although careful watch was kept for any lifting off. This blocking was proportioned for unit pressures of 100 lb. per sq.in.; 50% higher loading was allowed on the planking, under the roller tracks, to let some crushing occur at any unevenness.

The arrangement of roller tracks was almost identically the same as that used in the same contractor's job of moving the Coshocton bridge on the Panhandle, as described in *Engineering News*, July 15, 1915, p. 105. The pulling rigging was also the same. Two derrick cars set on the center of the middle span, one facing in either direction, handled four lines, one from each abutment or

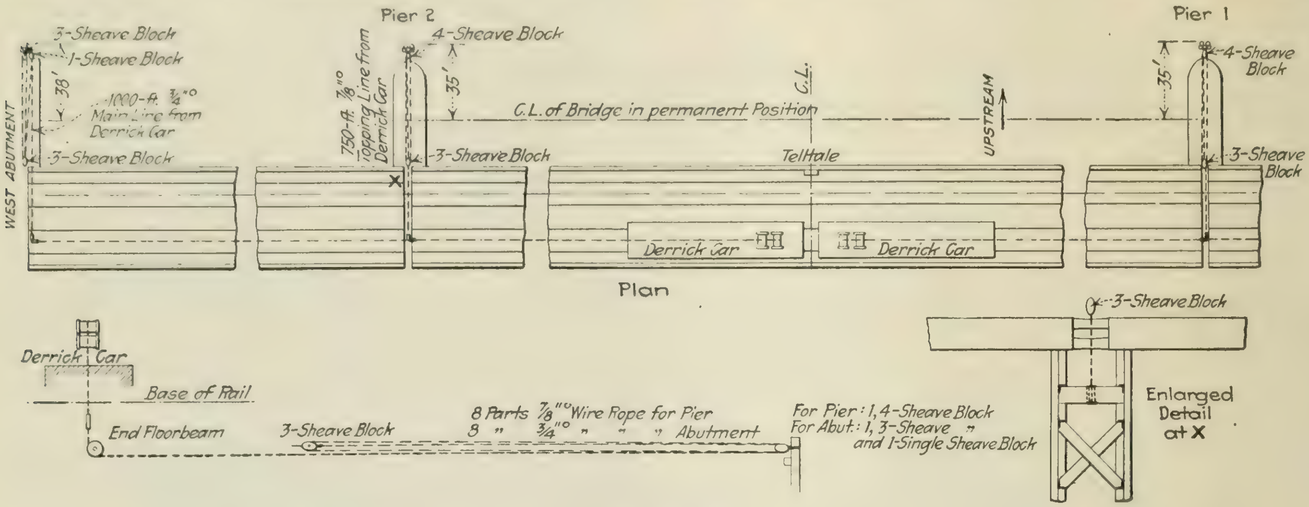


FIG. 4. RIGGING FOR ROLLING THE THREE-SPAN DAYTON UNION BRIDGE

pier, the line running from a hitch to the truss (or the two adjacent trusses) forward to a sheave at the upstream end of the pier, then back to the floor of the new bridge and up to a drum on the hoisting engine. Wires were run from a fastening on the pier to the bridge, and by extensions of metal sash-cord over to an indicator board at the middle of the bridge, carrying here tension weights and pointers on a scale marked on the board, showed at every instance the precise amount of movement on each pier or abutment. At the point fixed for the end of the move, end stops were fixed on the piers and abutments, the bridge to be pulled up tight against these.

Special care was exercised to take off all the rope from each of the four operating drums of the two hoists and rewind so as to have equal wraps on each drum at the start of the pulling. This gave the same pulling speed at all drums when running at the same speed and thereby made it easier to control the four separate hoist drums so as to keep the four moving points exactly abreast. The pulling succeeded so well that at no time in either move was the bridge as much as an inch out of line.

The moving was just as precise with respect to alignment with the direction of the pier girders. The new bridge has longitudinal distributing girders (a girder composed of four plate-girder ribs for the two spans on each pier) running lengthwise of the piers. This construction is adopted by the bridge engineer of the railroad company as a positive means for avoiding concentration of load on the pier masonry. The contractor had to set the pier girders before the move; and great care had to be taken to align them exactly at right angles to the bridge, because the bridge at the end of its move had to come with its shoe anchor bolts exactly in line with the anchor bolts through the pier girders. This succeeded so well that there was not ⅛-in. variation anywhere, and the anchor bolts could be dropped right into the holes.

Jacking Arrangement for Placing Spans on Permanent Shoes

When the bridge was in final position, it was necessary to take out both the blocks and the track and set the shoes. There was very little room on the pier for jacking, however. Temporary bolsters were made to occupy the positions shown by sketch in Fig. 3, and of the construction shown alongside. Setting these up and wedging them in place, the outer pair of blocks under the trusses could be split out, transferring their load to the bolsters. The rails of the roller track, both upper and lower, were spliced at points just at the end of the pair of middle blocks, as sketched. When the load on the outer blocks was removed, the outer sections of rails and track could be unbolted and taken out. This left place for sliding in the shoes of the span. The blocking heights were such that the shoes slipped in with 2 in. of vertical clearance. Nothing remained to be done but jack the span, remove the bolsters and the middle blocking and lower onto the shoes, after which the remaining track and roller sections could be taken out.

There was just room enough between the shoe and the middle track section to permit placing jacks. The jacking was done simultaneously for both truss ends on a pier.

The local man in charge of the successful erection and moving operations was H. S. Goodloe, superintendent for the Seaboard Construction Co., of which S. P. Mitchell is president. The work was done under the general direction of J. C. Bland, engineer of bridges, Pennsylvania Lines West of Pittsburgh.

The total moving weight of the three spans with their loading was: Steel of the three spans, 2427 tons; floor, 300 tons; two derrick cars, 180 tons; total, 2907 tons. In accordance with the contractor's regular practice the parts of the moving rig, including the tackle multiplications, etc., were laid out on the basis of three to five times the figures obtained with roller friction at 1%. By this method not only is ample safety secured, but also the speed of moving is reduced to a proper controllable limit.

Minneapolis Has Specially Prepared Industrial District

The experience of Minneapolis, Minn., in stimulating the industrial development of the city, by a prepared industrial district, shows a way for many municipalities to eliminate the existing unsatisfactory conditions.

Many of these cities unhesitatingly offer to desirable industries free sites, bonuses, stock subscriptions and other forms of financial aid as a condition of their location, while other cities employ all the pressure they can command to secure an industry for themselves. This competition has been so severe that many of the stronger concerns seeking locations have avoided civic bodies; weaker concerns, on the other hand, often deliberately seek out civic bodies in order to secure every possible aid.

The Minneapolis project was described by L. H. Brittin, General Manager of the Minneapolis Industrial District, before the annual convention of the Minnesota Surveyors and Engineers Society; the following notes are based on his paper.

The experience of Minneapolis in this field has not been different from that of the average city. About 20 years ago, in its race for industrial development it "bought" some 20 miscellaneous industrial concerns through the donation of free sites, bonuses and stock subscriptions.

Today only one of the original 20 survives and many of the pioneer business men cherish among their old papers an assortment of stock certificates of these defunct "spoiled children." This practice of buying industries evidently tends to develop a type of dependent industry.

There are at the present time in the United States five so-called industrial districts, two of which have been developed by railroad interests to increase tonnage, two by real estate interests as essentially gainful undertakings, and one—the Minneapolis Industrial District—for the sole purpose of stimulating the industrial development of the city. The Minneapolis district is therefore a pioneer in this field.

A municipal industrial district must satisfy several requirements:

1. Such a district must have certain very definite transportation facilities. Its trackage should be part of some "belt line" or "distributing and interchange terminals," as it enables its industries to be served by all railroads without paying a connecting-line switching charge.

2. It should have on its property a "joint freight station," where the manufacturer and distributor can handle both in-bound and out-bound less-than-carload freight for all lines and thus obviate the necessity of draying these shipments to a number of different freight stations.

3. It should be so planned in its arrangement of streets, tracks and terminals that each industry can have its side track parallel to the long axis of its building in order to assure the maximum car capacity in its side track.

4. It should be so planned that the depth of the various sites between street and track will accommodate the types of industries which will locate thereon. An industrial district may be in one of those cities occupying points of natural economic advantage as distributing centers, having say a minimum of 50,000 miles of trackage in a territory in which it has two million people within the zone of second-day freight delivery. Ninety per cent. of the sites in such a district should be so arranged as to accommodate buildings 80 ft. wide with side tracks parallel to the long axis of their buildings—a layout, in other words, that will accommodate branch assembling and distributing plants of eastern manufacturers' concerns. In those cities that occupy a natural economic advantage as manufacturing centers, at least 70% of the sites should not be less than 300 ft. deep from street to track to accommodate groups of buildings of medium sized manufacturing plants.

5. The ideal industrial district should have sub-soil conditions that afford excellent foundations close to the surface.

6. It should be located on a paved arterial street.

7. It should be well served by street-car lines and should have within a zone of 15-min. walk, or 15-min. combined walk and street-car ride, a sufficient population of "native born of foreign parents" or "foreign born" as will meet the requirements of its industries. For example, —a large eastern concern that has been establishing three or four branch manufacturing and distributing plants a year has found it profitable to appropriate for a "labor survey" approximately $10,000 for every $300,000 building erected.

8. The ideal industrial district should impose sufficient building restrictions permanently to safeguard the interests of industries locating on the property.

The history of the development of an Ideal Industrial District for Minneapolis may be outlined as follows: In August, 1914, the business men of the city incorporated under the laws of the state the Minneapolis Industries Association with an authorized capital stock of $300,000. One hundred and fifty-two of the leading business men subscribed an aggregate of $272,000,400, or an average of $1810 each.

In October, 1914, the Association purchased, with the aid of a bond issue, 200 acres of land located on an unimproved arterial street within two miles of the heart of the business center of the city and close to the main line of the Minnesota Transfer Ry.—the distributive and interchange terminal of all railroads entering Minneapolis and St. Paul. In January, 1915, the work of planning the general layout of this property was started.

In September, 1915, a contract was negotiated with the nine railroads owning the Minnesota Transfer Ry. to extend transfer trackage throughout the district, to erect and operate a joint freight station, and to install a railroad yard sufficient to meet the traffic requirements of the property. In December, 1915, the city installed sewer and water throughout the district. In July, 1916, the city paved the arterial thoroughfare connecting the district with the heart of the business section. In January, 1917, the physical development of the district was completed and five industries had been located thereon. Thus in 2½ years from the organization of the corporation the industrial district has become a reality, to a point at least where the promoters are reasonably certain of its ultimate success.

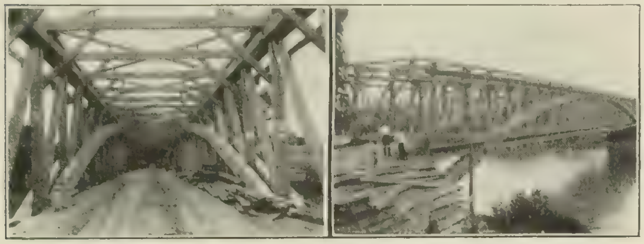
Typhoid Fever in the District of Columbia for the last five years (each ending June 30) were at the following rates per 100,000: 13, 13, 14, 23 and 18, these figures running from latest to earlier. For the 19 years ending June 30, 1916, the average annual typhoid rate was 40.4. The actual number of typhoid deaths in 1915-16 was 47 and the average for the 19 years named was 127.5.

Notes from Field and Office

Wooden truss span 250-ft. long—Moving a concrete culvert on rollers—Floating mixing plant—Telpher used on subway construction—Busy yard crane 25 years old

Is This the Longest Span Wooden Bridge?

The accompanying views show a bridge at Bridgewater, Rockingham County, Virginia, about 6 miles west of Harrisonburg. It was built in 1877-78 by William H. Grove, a bridge carpenter, and has recently been torn down to

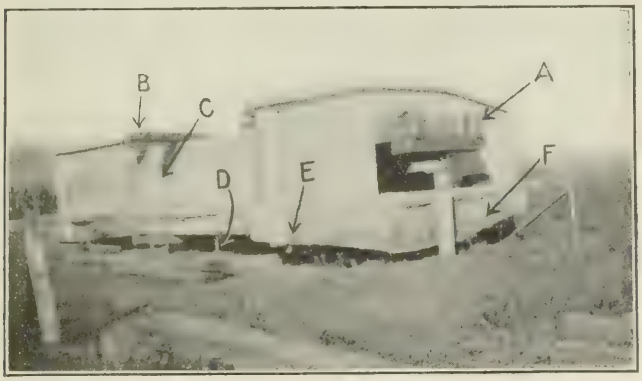


WOODEN BRIDGE OF 250-FT. SPAN NEAR HARRISONBURG, VA.

make way for a modern steel structure. It has a clear span of 250 ft. and had the reputation locally of being the longest wooden bridge in the world.

Moving a Concrete Culvert Intact

A reinforced-concrete box culvert 6 x 4 ft. in section by 24 ft. long and weighing 70 tons has just been moved a distance of 80 rods in Shelby County, Iowa. The accompanying view explains how the box was moved. To



CONCRETE CULVERT JACKED UP AND ON WAY TO NEW LOCATION

lift it from its former site, 4 x 8's 16 to 32 ft. long, indicated at *A*, were thrust lengthwise through the barrel.

To prevent the top from lifting off, sets of timbers *B* were bolted together with long 1-in. bolts or tie-rods *C*. The culvert was started from its bed by twenty-four 20-ton screwjacks *D*. Rollers were slipped under, and the culvert was pulled along by a capstan and horses. F. W. Sarvis, County Engineer, Harlan, calls attention to this job.

Improved Details of Floating Concrete Mixing Plant

By A. W. Kreamer*

In studying the construction of the concrete mixer boat for the Ohio River dam work, described in *Engineering News*, Feb. 1, 1917, p. 169, several details of existing practice were found to be at fault. In the new plant, therefore, the designers made a special effort to improve these details or to eliminate the faults found in other plants. The simplicity of the new designs has

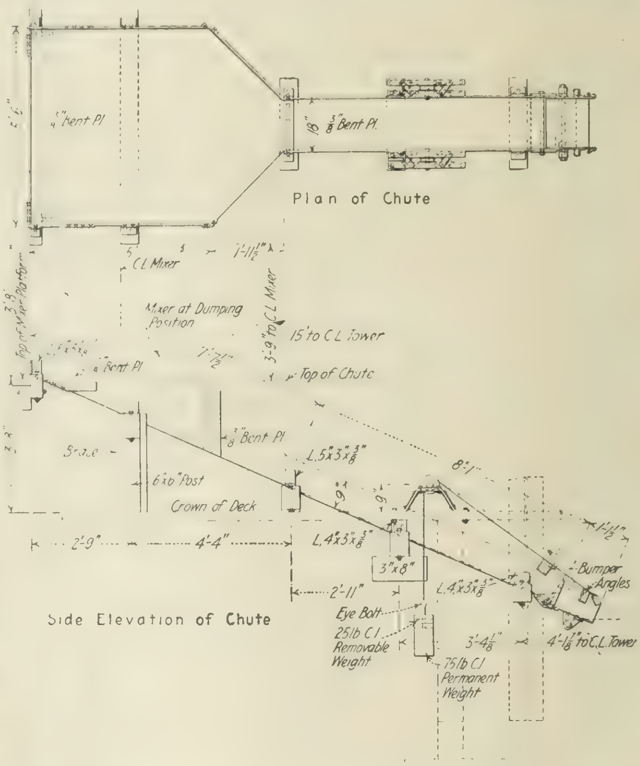


FIG. 1. TILTING CHUTE FEEDING ELEVATOR BUCKET

proved a big feature in their success. While they are applied in this case to a floating mixer plant, there seems to be no reason why they cannot be used easily to advantage on other types of concreting plants. The details may be enumerated as follows:

In tower mixing plants bent guides at the bottom of the towers have caused spill of concrete while the bucket was being started and therefore much valuable time was lost due to sticking and binding of the bucket. At the same time the discharging chute from mixers to buckets causes trouble by allowing concrete to pile up under the bucket while it is up the tower. In the Wheeling plant

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these difficulties were eliminated by making straight guides for the tower and adding an automatic tilting section to the end of the discharge chute.

Details of this section are shown in Fig. 1. It will be noted that with the addition of two lug angles on the bucket the tilting chute is held in its proper open position by engaging with a roller on each side of the chute. As the bucket goes up the tower the tilting part of the chute is pulled into the closed position by two counterweights attached to the outer end of the chute by means of wire ropes that pass over to idler sheaves. As the bucket returns to the bottom of the tower the lug angles again engage with the rollers and pull the tilting chute into the open position. The tilting chute in its closed position, while not watertight, is cement, grout or concrete tight as providing storage capacity of about 2 cu.ft. of concrete that would otherwise mean either spill or loss of time. This enables the hoisting engineer to get a maximum speed out of his bucket, as well as to insure him against spilling of concrete under the bucket when it is not at the bottom of the tower. The arrangement may easily be enlarged upon to provide storage for a full mixer batch.

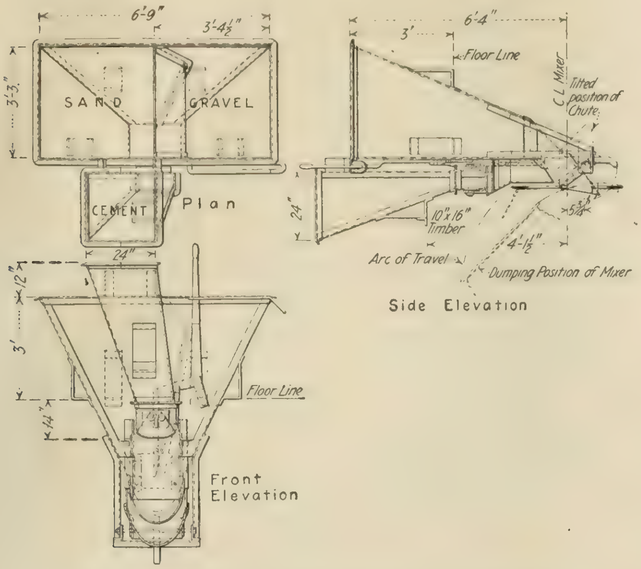


FIG. 2. SECTIONALIZED MIXER HOPPER

In some plants the slow discharge of the measuring hoppers into mixers, along with uncertain gaging of quantities, and much trouble from cement dust in getting the cement into the batch have all caused trouble. In the Wheeling plant specially designed hoppers have been provided to alleviate this trouble. Details are shown in Fig. 2. It will be noted that there are three separate compartments for sand, gravel, and cement, respectively, the sloping sides of all of which vary from the vertical to about $6\frac{1}{2}:12$. The arrangement shown is made to work in conjunction with the tilting Smith mixer, making necessary the gravity tilting chute under the hoppers. The sand and gravel hoppers are provided in the field with marker lugs on the inside, thus gaging the quantities as accurately as desired. Because of the handling of the cement in bags, the cement hopper here shown needs no markers. However, such could easily be placed where desired when bulk cement is used. A light wooden partition built at the back of a cement hopper reduces the cement dust trouble to the man at the top of the hopper. The contents of all three hoppers are discharged at one time by the operation of a belt crank lever.

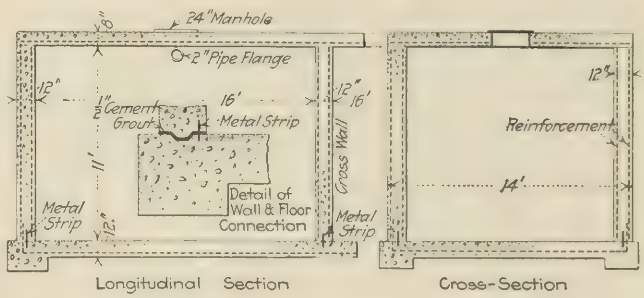
In some plants an inadequate water supply, together with an uncertain measurement of the water, has caused a poor grade of concrete. In the Wheeling plant this was much improved by the provision of a duplex service pump working against the safety relief valve. A quick-opening gate valve and a disk meter with a dial were placed in the water line at a handy position, near the measuring hoppers. The meter dials are graduated from 0 to 100 gal., and have an adjustable pointer which can be quickly set back to 0 after each discharge into the mixer. Thus the water supply can be quickly gaged while the operator may change amounts at will.

In some plants there has been loss of time in changing the inclination of boom, and there has also been no safety device to prevent the fall of the boom should the engineer have trouble with his engine. In the Wheeling plant this is eliminated by the addition of a locking device located near the engine. The line from the engine drum to the locking device may be slacked, thus relieving the strain on the drum shaft. All that is necessary to raise and lower the boom is to start the engine.

Joint in Concrete Oil Tank

A reinforced-concrete oil tank of rectangular shape, for the Charles City Gas Co., at Charles City, Iowa, has a metal cutoff in the joint between walls and floor. The tank is 35 x 14 ft. outside, with 12-in. walls and crosswall, forming two compartments 12 x 16 ft., 11 ft. deep. Its capacity is 30,000 gal. The bottom is a 12-in. slab, with footings under the side and end walls. The roof is an 8-in. slab. All the steel reinforcement consists of sheets of triangular-mesh wire netting, two in each wall and one each in the floor and roof. Each compartment has a 24-in. circular manhole and a 2-in. pipe flange. The tank is entirely underground; and as it is entirely in sandy soil, considerable timbering was necessary.

The floor (with footings) was built first, then the walls and partition and finally the roof slab. In order to make a tight joint between the floor and the walls, the former was grooved; and while the concrete was soft, a 6-in. strip of galvanized iron was inserted, about 62 in. from the inner face of the wall and about 4 in. above the floor. Laps were made 8 in. long. When everything was ready to begin pouring the walls, the contact surface of the floor was well cleaned and washed with water and then given a $\frac{1}{2}$-in. coat of thick cement grout. The new concrete was placed at once upon the grout. The wall forms were of 6-in. flooring timber nailed to 2 x 6-in. studding spaced 2 ft. c. to c. The wire mesh for the walls was tacked directly to the sheathing of the forms, so as to be about 1 in. from the surfaces. The concrete was a 1:2:3 mix of cement, sand and gravel.



OIL TANK OF REINFORCED CONCRETE

This tank was built by William E. Frudden, of Charles City, Iowa, who has furnished the information. The joint has proved tight, and a second tank is to be erected according to the same general plan.

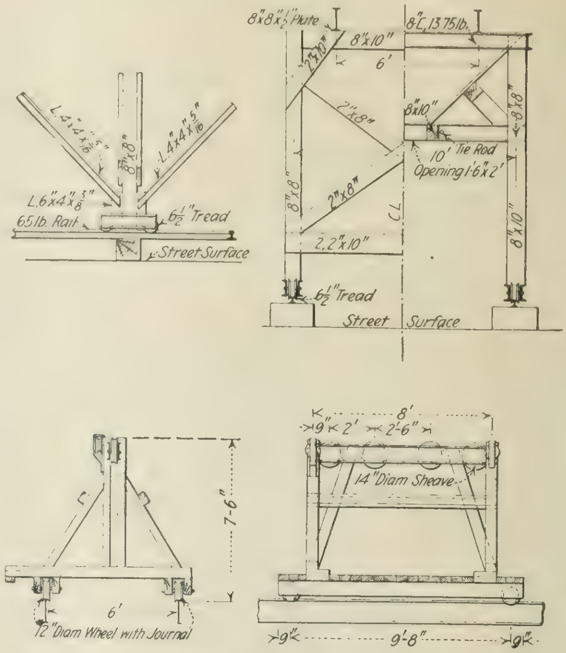
Novel Cableway Hoist and Trolley Used on Subway Excavation

The traveling telpher shown in the accompanying views and sketches has been used by Mason & Hanger-MacArthur Bros., Inc., contractors for Sections 1 and 5 of Route 8, Eastern Subway, 14th St., Brooklyn, N. Y., part of the system of subways now under construction in New York City. The machine is the outcome of studies into the development of cableways for removing the excavated material from cut-and-cover excavation that had to be done without interfering with traffic.

There were many difficulties connected with the use of cableways, not the least among which were the difficulties of moving the heavy towers forward over the cut. The machine developed resembles a cableway in that the bucket carriage runs along under the control of a cableway hoist, but it differs in having the carriage supported on a wood and steel trestle instead of being suspended from a main cable. When the excavation for a given set-up is completed, the trestle is separated into two lengths and pulled ahead 150 ft. to the new set-up by its own power. A complete movement can be made in half a day, counting from the time work is knocked off on the old excavation to the start of the new.

One section of the trestle consists of six spans, made up of a track of 10-in. 25-lb. I-beams 30 ft. long, supported by timber bents and braced by $4 \times 4 \times \frac{5}{16}$-in. angles in the vertical plane and $2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$-in. angles in the horizontal plane. The timber bents consist of a pair of 8 x 8-in. posts, and 8 x 10-in. cross-cap or plate stiffened by 2 x 8-in. main diagonals, 2 x 10-in. corner diagonals at the top, and a pair of 2 x 10-in. horizontal cross-ties below the main diagonals. Each post rests on a truck formed by a pair of 8-in. $13\frac{3}{4}$-lb. channels supporting a double-flanged wheel, with $6\frac{1}{2}$-in. tread, placed 2 ft. on centers. These trucks rest on 65-lb. rails, supported under the point where each post is to rest by 12 x 12 timber blocks 2 ft. long. No other blocking is used under the rails during excavation or moving forward.

The second section of the trestle is $34\frac{1}{2}$ ft. long and consists of a three-panel bin and one short span of

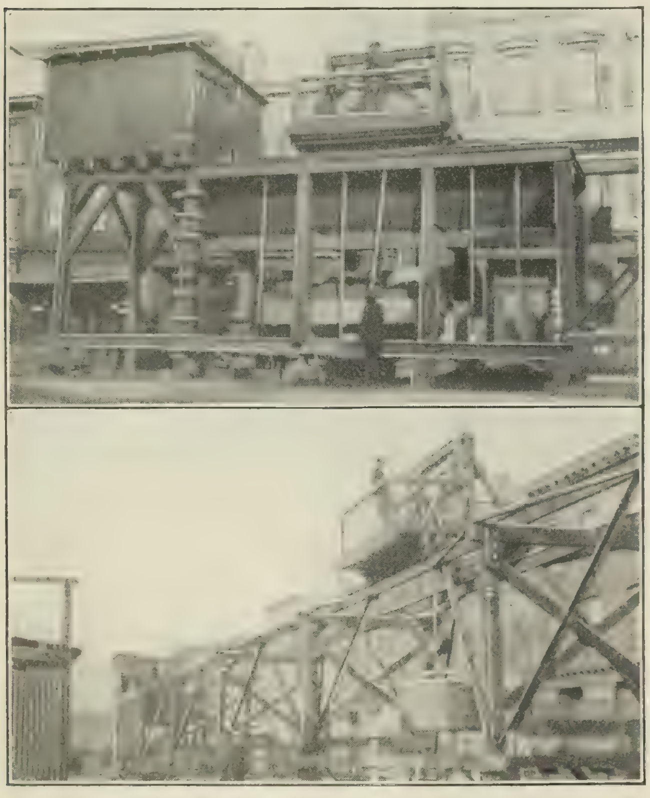


BENT AND CARRIAGE DETAILS OF TRAVELING TELPHER

trestle. The bin is formed by throwing across, between the main posts of the bents, pairs of 8-in. 13.75-lb. channels, with a pair of 8 x 10-in. stringers 2 ft. apart between these. The floor of the bin is of 3 x 8-in. planks, inclined between the stringers and the upper corners of the bents. The middle of the flooring is supported by 8 x 8-in. knee-braces running to 6 x 8-in. middle stringers. Sliding bottom doors ($2 \times 1\frac{1}{2}$-ft. opening) are operated by long pipe handles. An extra span of the trestle beyond the bin supports the hoisthouse. The outer supports for this are simple 8 x 10-in. posts, with corner diagonals.

All the posts of the four-panel bin section rest on continuous pairs of 8-in. 13.75-lb. channels instead of on the short trucks used under the rest of the trestle. A single wheel is placed 10 in. off the center of each post. After the set-up has been completed, following a movement, the bin and hoist section of the trestle are securely blocked up off the wheels and rails.

In the hoisthouse is a double-drum cableway hoist driven by a 50-hp. 850-r.p.m. three-phase electric motor. Both drums are 24 in. in diameter and 26 in. long between flanges and run at 400 r.p.m. The line for traversing the carriage is continuous, and both ends come off the middle drum, one end going directly to the carriage and the other threading through guide sheaves on the carriage, going over a return sheave at the far end of the trestle and coming back to the carriage for fastening.



TRAVELING TELPHER USED IN BROOKLYN, N. Y.

The line for lifting the buckets is single; the free end goes over guide and turning sheaves on the carriage and around a single-sheave block attached to the bucket, being finally fastened to the far end of the trestle. Thus a two-part line is secured at the bucket. The drum for this line has a special renewable long-radius flange to ease off the crowding of the rope at the ends of the drum.

In using this machine, the empty 1½-yd. bucket is run out from the bin to some point on the excavation and lowered, when it is exchanged for a loaded bucket, which is brought out from the working breasts on light trucks running on temporary transverse narrow-gage tracks. This bucket is then lifted clear of the trestle and carried over the bin, where it is dumped by tilting. The average performance of this telpher is 150 buckets per working day of 8 hours. The maximum performance has been 260 buckets or 400 yards of excavation brought to the bin.

The machines were designed and assembled by Mason & Hanger-MacArthur Bros., Inc., of which H. B. Hanger is President, John J. Watts, Secretary and Treasurer, and E. A. Groves, Chief Engineer. The hoist was made by S. Flory Manufacturing Co., Bangor, Penn. The buckets were specially made for the contractors by G. L. Stuebner & Co., Long Island City, N. Y.

Cantilever Yard Crane of Historical Interest

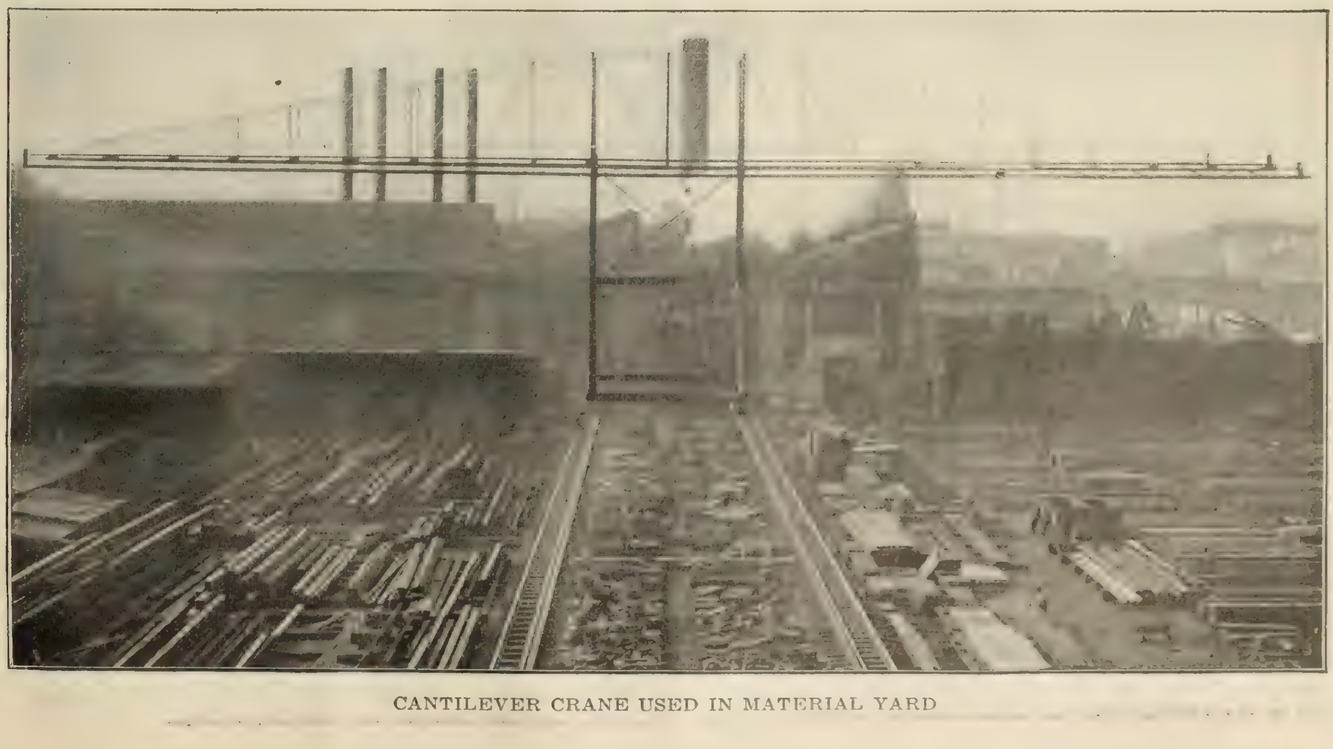
A historical piece of contractors' equipment, one of the old Brownhoist cantilever cranes built in 1892 for the Chicago Drainage Canal work, still survives and is in daily use, doing service as yard crane in the shop yard of the Brown Hoisting Machinery Co., Cleveland. The crane is reported to be efficient, besides being historical.

The yard is rectangular, about 300 ft. wide, and the one crane covers its full area, traveling on a track through the middle of the yard. A traveling crane of bridge type would require a number of runways, and as many cranes, while this one machine covers the entire area.

The crane has a trolley travel of about 313 ft., and a clearance height from ground to trolley track of about 50 ft. It is carried by four 4-wheel equalized trucks running on two tracks 37 ft. on centers. The following note on the history of the machine was furnished by the company, at our request:

At the start of excavation on the Chicago Drainage Canal it was found to be a very difficult problem to get the spoil from the canal back to the spoil bank. Several methods were tried but they all proved to be very expensive. Finally several of the contractors came to our company with the problem, with the result that the Brownhoist Cantilever Crane was designed and built, the first of its type in the world. There were twelve of them built during the years of 1892 and 1893, and all were placed on this one job with very satisfactory results. This is putting it mildly, because the crane proved to be a huge success in hoisting the excavating material and taking it back to the spoil bank. The material was handled in 3½-ton rock buckets and the crane and trolley were designed for five-ton load. These cranes were like the one shown in the illustration with the exception that the cantilever was inclined 2¾ in. per foot to the horizontal. They had a trolley travel of 343 ft. They were steam operated.

After completion of this work the cranes were returned to the factory and most of them were sold to iron and steel companies throughout the country. In nearly every case the cantilever was placed in horizontal position. Some of the cranes were refitted for electric operation, but generally speaking they are being used today the same as they were on the canal twenty-five years ago. One of the cranes has been used for several years on the Panama Canal and is still being used at Cristobal. Two of them were shipped to foreign countries, one going to Belgium and one to Germany. One of them has been used in the construction of the New York State Barge Canal and one is being used in our storage yard as shown in the picture. It handles sheets, bars and all shapes from the yard to the shop.



CANTILEVER CRANE USED IN MATERIAL YARD

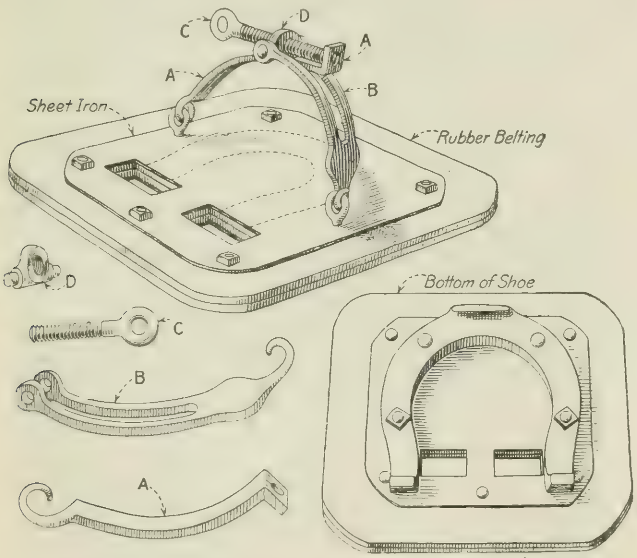
FINE AGGREGATE

Mechanical Ditching Not Always Cheapest—As an example that ditching machines are not universally economical, the big traction ditcher shown in the view was recently abandoned by its owners after trial on the Cudahy ranch in Imperial Valley, California. The reasons given are that the fuel and labor costs were too high and that the machine was adapted only for land of uniform slope or where the canal line would follow approximately the same grade as the ground surface. The machine was unable to make cuts and fills of

ABANDONED TRACTION DITCHER IN IMPERIAL VALLEY

varying depths, and of course it could make only one size ditch without a complete change of blades. The ditch which this machine was to cut was 3 ft. deep, 3 ft. 3 in. on the bottom and 10 ft. across the top. It was operated by two 25-hp. gasoline engines. It is reported that these ditchers have been used at Valerie, Mont., but in the Imperial Valley mules and fresno scrapers have been found better adapted to local conditions.

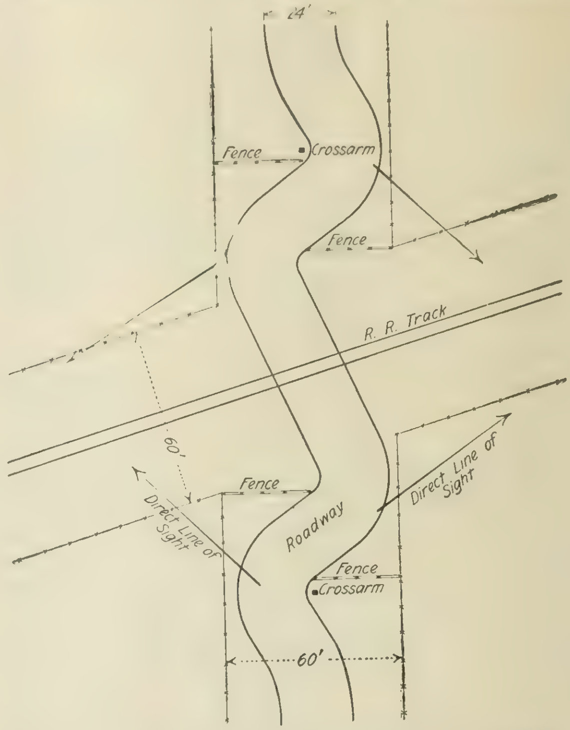
A Horse Snowshoe for use on the soft roads of the Sierra Mountains of California is shown in detail in the sketch. It consists of a plate of sheet iron ⅛ in. thick and 9 in. square, with rounded corners. This plate has two 1½-in. rectangular slots cut through it 1½ in. apart, which are for the heel calks to fit in and are made long in order to accommodate horseshoes of different sizes. The shoe is held firmly by a clamp attached to the plate on each side by eye-bolts. Beneath the plate are two thicknesses of five-ply rubber belting 11 in. square, with rounded corners, and underneath the belting is a large horseshoe 9 in. long. Plate, belting and horseshoe are firmly bolted together by ¼-in. bolts and by the eye-bolts.



DETAILS OF THE CALIFORNIA HORSE SNOWSHOE

The clamps are forged out of ⅝-in. flat iron and conform to the shape of the hoof. The swivel bolt fastening the straps together is ½ in. in diameter by 4 in. long, with a conical end to fit in the bearing hole. S. H. Brockunier, of Nevada City, Calif., who describes this shoe in "Engineering and Mining Journal," states that the snowfall in the Sierras is usually quite heavy, but that the temperature is comparatively high, resulting in soft moist snow very difficult to travel over. A horse of steady nerve will learn in half an hour how to travel on snowshoes. A pair of horses, either in span or tandem, wearing snowshoes can cover 4 or 5 miles per hour with 500 to 1000 lb. of freight.

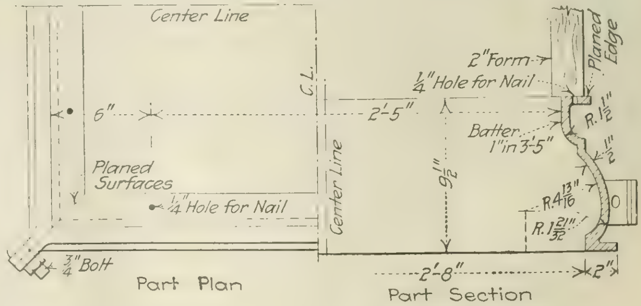
A Scheme To Avoid Grade-Crossing Accidents is proposed by R. G. McMullen, a civil engineer of Portland, Ore. As illustrated by the accompanying sketch, this scheme consists of placing obstructions in the roadway in such a manner as to compel the motor-car driver to slow down and to face both up and down the railway track before he crosses the rails. With this construction at a grade crossing, one approaching apparently sees the road fenced across, but upon closer view discovers the way around and proceeds at necessarily slow



GRADE-CROSSING MAZE DESIGNED TO LESSEN DANGER OF ACCIDENTS

speed on account of the reverse curves. It is advocated that all wooden fences at the crossing be white and that where stone fences are used a liberal amount of whitewash or white cement be applied. The fences should lap on the line of sight approaching, and the usual railroad crossarms should be one of the center posts, to bring it into more prominence.

Cast-Iron Forms for Column Bases have been adopted on track-elevation work being done by the Chicago, Burlington & Quincy R.R. The subways involve the construction of rows of columns for the intermediate bents. The shafts of the columns are rectangular in section, with chamfered edges, and are made easily in wooden forms. But for the molded bases cast-iron forms are employed, thus simplifying the difficult



CAST-IRON FORM FOR COLUMN BASES

part of the formwork and giving a smooth, even surface to the concrete. The forms, put together with bolts, were designed under the direction of G. A. Haggander, Bridge Engineer, and are made at the company's shops.

Editorials

Not a Terminal, But a Junction Point

The present issue of *Engineering News* is the last which will appear under that name—a name which has been truly a household word to the engineers in America for more than a generation. It is in no sense, however, to be considered as marking the termination of this journal's life. The new journal that will be issued henceforth as its successor, *Engineering News-Record,* will be a continuation of *Engineering News* and of the *Engineering Record* as well, preserving all the policies and traditions and experience that have made the two journals a power for progress in the broad field of civil engineering.

As a matter of convenience in reference, Vol. 77 of *Engineering News* terminates with this issue, and an index to the numbers issued since Jan. 1 accompanies this number. The first issue of *Engineering News-Record,* to appear on Apr. 5, will be Vol. 78, No. 1. This volume will be terminated with the issue of June 28, and thereafter the volumes will extend over six months' periods, as has been customary hitherto on the separate journals.

The trainload of passengers that has been carried forward on the *Engineering News* line will next week be united with the other trainload that has traveled on the *Engineering Record* line, and the journey is to be continued, with motive power and equipment adequate for the greater load and for the new country that is to be traversed.

Public Control of Railway Terminals

For many months the plan of the New York Central to rebuild at great expense its freight line along the Hudson River has been the subject of most active controversy in New York City. To briefly state the case for the benefit of those unfamiliar with local conditions, the freight entrance of the New York Central lines to New York City is over a double-track railway, which leaves the main line at Spuyten Duyvil, at the northern end of Manhattan Island, follows along the shore of the Hudson River at the foot of Riverside Park, and connects with an extensive freight yard at 60th St. From this yard trains are moved to terminal yards farther downtown along tracks laid in 10th and 11th Aves.

These lines have for years been inadequate for the volume of traffic which they have to handle, and public protest against the operation of trains through the city streets has long been active. For many months a contract has been pending between the New York Central company and the city authorities, represented by the Board of Estimate and Apportionment, whereby the company proposes to spend from \$50,000,000 to \$100,000,000 in elevating its tracks, introducing electric motive power, enlarging its yards, and covering its tracks along park property so that they will not be an objectionable feature.

There is no doubt whatever that the proposed improvement as an extension to the freight-handling facilities of the city is urgently needed. Various prominent business interests, such as the Merchants Association, have been active in support of the project. From the first, however, there has been evident a very large amount of public opposition. A large part of this opposition is influenced by the idea that the work proposed would be a serious injury to New York's famous Riverside Park, both during construction and after completion. There is, however, a more important opposition, which is based on the underlying idea that a great city should control the terminals of both rail and water transportation lines on which its commerce depends. In the public agitation going on in a dozen American cities at the present time over proposed expansion of railway terminals, this is the idea which finds greater and greater prominence.

Public opposition to the New York Central plan was effectively voiced last week in a report made by the Public Service Commission at the request of Governor Whitman, in which the pending contract is strongly opposed. The chief ground of the opposition is that the contract gives to the New York Central not merely a franchise, either for a limited period or for perpetuity, with opportunity to readjust its conditions at certain periods, but absolute ownership rights to its line through the city streets and its connecting terminals.

It is quite within the possibilities that it may at some future time be greatly for the city's interest that the elevated freight line, which the New York Central Ry. proposes to build, should be made available also for the cars and trains of other competing companies. There is obviously no room in the limited space on Manhattan Island to permit the construction of other competing railway lines there. Hence if this line of the New York Central Ry. is constructed, it is believed by many that it should be open to the use of all railways who can at any later date find means of access to it, as might be possible should a bridge be constructed across the Hudson.

The attitude of the Public Service Commission may well be judged by the following excerpt from its report:

> There is involved the public policy of the state that the present and future interests of the state and city, of the general public and of shipping and mercantile interests shall be adequately protected. In granting the right to use public streets and places, the duty devolves upon the municipality to protect public rights. This has usually been accomplished by the grant of franchises for limited periods, or else in perpetuity, with periodic readjustment of compensation, to give the opportunity at stated periods to revalue such public grants. Such franchises in modern form have contained other numerous provisions for public protection. A fine type of these grants are those granted for the Pennsylvania improvement in and through New York City.

Since the report of the Public Service Commission was issued, it has been announced that radical changes and alterations would be made in the contract between the city and the company before its final execution. It is probable, however, that the entire plan will be shelved for the present. Great as is New York City's need for an improvement of the freight terminal facilities on Manhattan Island, those who have given most study to the subject are agreed that no piecemeal development

or development made in the interest of a single corporation can fully serve the needs of the city.

It seems likely that a new movement to have a broad study of transportation facilities for the entire port of New York undertaken by a commission representing both New York and New Jersey may be one factor in bringing about a delay in New York Central's plans until the result of that study can be known. The railway company will hardly object to a certain amount of delay, as it would in any event hardly wish to push work on so extensive an enterprise until prices of labor and material return to somewhere near a normal figure.

Saving Engineers Labor

Every reader of *Engineering News* will be interested in the announcement that work is already under way on a General Index for the volumes of *Engineering News* from Jan. 1, 1910, up to the present issue, a period of seven years and three months. At no previous period in the history of *Engineering News* has such a large amount of permanently valuable matter been published as in the past seven years. When one endeavors to look up the information which has been published in that time on a given subject, he has to search through the separate indexes for each of these fourteen volumes. As it is often necessary to search under three or four different headings in an index to find all the material that has been published on a given subject, it may happen that a search will require looking in fifty or more places in the separate volume indexes. When the searcher has at hand a General Index to all these volumes, the task that would require hours can be accomplished in a few minutes.

By way of illustration, suppose an engineer desires to look up certain information relating to piles and piledriving contained in the volumes of *Engineering News* from 1905 to 1909. By referring to the General Index to these volumes, which was published in 1910, he will find under the headings "piledrivers" and "piledriving" references to a score of articles and under the heading "piles" references to some eighty or more articles. It is an easy matter to look over these references and then turn to the articles bearing on the class of work in which he is particularly interested.

With this book index at hand, a file of bound volumes of *Engineering News* becomes a veritable encyclopedia of current engineering practice. It is in fact superior to any encyclopedia, since it is more up to date and is made up largely of contributions from acknowledged leaders of the profession.

As the older readers of *Engineering News* are aware, the earlier volumes of *Engineering News* were covered by General Indexes published years ago. The first of these books covered the ten-year period from 1890 to 1899 inclusive; and the later books covered the five-year periods from 1900 to 1904 and 1905 to 1909. Those who have used these earlier General Index volumes will fully appreciate the great value to the profession of the new volume covering the years from 1910 to the present time. It is expected to have the new volume completed and ready for distribution before the close of the present year.

It may be here stated also that it is the present intention, at the end of a suitable period, to make the volumes of the new *Engineering News-Record* similarly available for convenient reference by the publication of a General Index. Subscribers, therefore, will have a strong incentive to preserve and bind these volumes for future reference.

We are of course aware that many readers feel unable to keep and file their volumes on account of the difficulty of carrying them about from place to place when they change location, as most young engineers are apt to do frequently. To meet the needs of this class of engineers there should be a file of bound volumes of this journal available for ready reference in every public library.

Many public libraries already possess such files. Where libraries do not have them, it is only because the librarian in charge does not understand the importance and value of the service that a library may render in this way to engineers and to the public.

It is not only the young engineer who cannot carry a file of bound volumes about with him who will benefit from such library files. It not infrequently happens that a consulting engineer may be distant from his office and desire to look up some matter of engineering practice. It may be a matter of great importance to him to be able to go to a public library and refer to a file of bound volumes of *Engineering News* to hunt up certain information.

Readers of *Engineering News* can render a real service to their profession by urging upon those in charge of public libraries in their locality the importance of obtaining and keeping available for reference the back volumes of this journal and a complete file of the new *Engineering News-Record.*

Vanishing Typhoid, with a Bit of Editorial Retrospection

Gratifying evidence of the progress of applied sanitary science and improved public-health administration is afforded by the rapid decline of typhoid fever in the United States and Canada. In years now happily long gone, it was stated again and again in these columns that as a general proposition a city with a typhoid death rate of 20 or more per 100,000 population was evidently suffering from a polluted water-supply.

Doubtless that was largely true, but later advances in the knowledge of typhoid warrant the conclusion that public water-supplies then got more than their due share of the blame for typhoid fever. However that may have been, typhoid began to decrease with the substitution of naturally purer or artificially purified sources of water-supply for grossly polluted ones. It decreased still more when health boards began to get effective sanitary control of milk supplies and of other foods subject to pollution by typhoid discharges.

Hypochlorite treatment and later liquid chlorine, combined with the growing (though as yet generally inadequate) state and local sanitary control of water supplies, have gone far toward eliminating the typhoid germ from drinking water. With the heavy decline in typhoid cases through water-supply and other sanitary improvements, better health administration, better medical treatment and more and better trained nursing there are of course fewer typhoid germs set loose to pollute water, milk and other foods, for hand-to-mouth infection.

New York City in 1916, to cite the record of a single city, had an annual typhoid death rate of only 4 per 100,000. This was a decline from a rate of 12 no further back than 1910 and 1911, and from 6 in both 1914 and 1915. In typhoid deaths the decline was from 558 in 1910 to 215 in 1916 and in cases from 3582 to 1617. If the comparison were to be carried further back, it would of course be even more notable.

In this, its last issue under the present title, perhaps *Engineering News* may be excused for saying that it feels it has had some part in bringing the typhoid scourge well down toward the vanishing point. Twenty-five years ago (Apr. 21, 1892) there was published in *Engineering News* an epoch-making paper entitled "Typhoid Fever in Chicago," by Prof. William T. Sedgwick and Allen Hazen. The paper had been read at Boston, on the previous Jan. 22, before the American Statistical Association. It was a veritable "Lochiel's Warning" to Chicago and the world against the typhoid danger from the Chicago water-supply, incident to the approaching World's Fair at Chicago in 1893. That the warning was needed no one now will deny in view of the fact that the typhoid fever death rate for Chicago was 166 per 100,000 in 1891 and during the previous ten years had ranged from 47 to 105.

There had been, if not an attempt to suppress the paper just mentioned, no effort to give it the widespread publicity it deserved. A junior member of the editorial staff of *Engineering News*, backed by the late A. M. Wellington, then in the prime of his brilliant editorial career, went to Boston, met Professor Sedgwick for the first time, received in a never-to-be-forgotten hour his first real knowledge of the scientific relation between water-supply and typhoid fever, secured the paper on "Typhoid in Chicago," with permission to publish it, and hastened back to New York and made it ready for *Engineering News* of Apr. 21, 1892. The paper, as might be expected from its authorship, was a masterly array of facts and conclusions. By means of tables, diagrams and text forceful comparison was made of typhoid cases and deaths in Chicago, New York, Philadelphia, Boston and various foreign cities. By these means and by telling extracts from official reports, Chicago's long-recognized need for relief from a typhoid-infected water-supply was shown beyond dispute.

The publication of this paper had a profound and widespread effect, in Chicago and throughout the United States. From that date to this *Engineering News* has spared neither pains nor space in collecting, presenting and interpreting data showing the connection between polluted water and typhoid and how the danger can be overcome by legislation, improved sanitary administration, and particularly by the installation and efficient operation of water-purification plants. This is of course only a small part of its fight against sanitary and other evils in the domain of engineering. The whole program will be continued onward from Apr. 5 next in *Engineering News-Record*.

A New Departure in Advertising

The fact that the business aspect of the advertising pages of a modern technical journal is not allowed to exert an influence on editorial effort, does not preclude the editors taking a keen interest in what is advertised and how. And when is seen as novel and useful a departure as is found in this issue of *Engineering News* comment here is proper and natural.

Coöperation in advertising has been considered by many minds, and schemes more or less resembling the Buffalo Power Station group of pages have been proposed. But it has remained for Mr. Barrett Smith to coördinate and unite the publicity efforts of many who contributed to the successful completion of this great steam plant. The reader's interest in each page is greater, because of its association in the group, than the same space and display promiscuously inserted. The extension of the scheme is inevitable.

Notice to Subscribers

The consolidated Engineering News-Record will be sent to all subscribers of both Engineering News and Engineering Record for the full unexpired terms of their present subscriptions. Subscribers to both papers will receive Engineering News-Record for the **combined** unexpired terms of subscriptions to both papers.

For instance, if you have five months due you on Engineering News and six months due you on Engineering Record, you will receive the Engineering News-Record for eleven months before a renewal is necessary.

Letters to the Editor

Water Rights and Common Law

Sir—The communication of H. B. Sweet in "Engineering News" of Mar. 22 contains a note of protest whose parallel might be found among the letters of the leading engineers of India, northern Italy, France and Spain, 50 or 75 years ago. While the court cases referred to by Mr. Sweet may furnish opportunity for the engineer to discredit himself, yet it seems to me that these controversies should encourage him to compare the procedure under our court domination with that which has been adopted in many foreign countries where the English common law has not been accepted.

As I view it, the fundamental trouble is not with the engineer. With us, water rights are determined by court decree rather than by officers or boards having technical qualifications. Under the common law we have nothing but theories which have been inherited from a country which is but slowly overcoming feudal influence. The common law as applied to water resources was not intended to protect the many private and public uses of water common in this country. It developed as the English House of Lords promulgated rules and regulations for the protection of the great landlords of that country.

Our courts have not made a record in this kind of work to which they can point with pride. They begin with a mistaken theory, and every case brings to light new questions which cannot be definitely decided. This condition always results where the few fundamental principles relating to the administration of water resources are ignored. In every civilized country, with the possible exception of England and the large majority of our states, water resources are administered under laws which embody wise principles, rather than by court decree based on a single, impossible doctrine. Even the English colonies, with the possible exception of eastern Canada, which has been influenced by the practice here, have abrogated the common law in this particular. Our mistake, fundamentally, is that we have not provided the necessary laws and machinery to support an adequate department for this kind of work. In the absence of these, an appeal must be made to the courts. Under this careless system, we have obliged the courts to enter the field of administration and, in dealing with the common law, they must also become legislators.

I agree with Mr. Sweet in so far as he goes. Engineers will never be satisfied with the kind of stream administration that is now afforded by many of our states. After engineers have been actively engaged in the administration of water resources for a term of years, they are naturally distressed when obliged to give testimony in a court which relies upon the common-law doctrine. It is a shock to such engineers to find the court building up theories which have no foundation in justice or reason and which never lead to an equitable decision.

It is possible that engineers should be criticized because their testimony in these cases is not of the kind to bring harmony. It might improve matters if each court were to employ an engineer and rely upon him for technical advice. But the real trouble is more deeply seated. Ample proof of this is found in the published court decisions. If courts agreed, there would be some cause for feeling that they had at least touched upon one of the fundamental and necessary principles at some point. We will have no relief until the reform extends far beyond the field immediately influenced by the engineer who acts as an expert witness.

CLARENCE T. JOHNSTON.

Ann Arbor, Mich., Mar. 24, 1917.

Reinforced-Concrete Patents Defended

Sir—In your issue of Dec. 28, 1916, on page 1240, in an editorial reply to Mr. Haynes, you say "it is against public policy and unprofessional" for the engineer "to claim a monopoly in his solution of such a problem unless he has really made an important advance in the state of the art."

I am convinced that your journal is mistaken in the general view it has given to its readers as to validity of patents in reinforced-concrete structures. At the present time seven patents on structural improvements in reinforced concrete have been held valid by United States Circuit Courts of Appeals, the final authorities in patent matters. They are the Norcross (219 Fed., 188), Bone (221 Fed., 944), Thacher (219 Fed., 909, 234 Fed., 640), Ransome (201 Fed., 528), Ferguson (236 Fed., 924), Hennebique (163 Fed., 300), and Nolte (206 Fed., 666) patents. Only one, the Turner (211 Fed., 466) patent, has been held invalid in a higher court. The references are to the number of the "Federal Reporter" and page, so that the above statement can be confirmed in any law office.

In each of these cases the defense of mere mechanical skill was a part of the attack upon the patent, as it is in every defense, for it is part of the standard answer in defense of any infringement suit and is given as one of the defenses in all textbooks on patent law.

Recently several lower-court decisions have been rendered adverse to structural patents in reinforced concrete, but these decisions are all pending appeal to the higher court. In nearly every case these patents have been held invalid in lower court upon technical interpretations of disclosures found after years of search in rare technical journals not known to the engineering profession in this country. With the exception of the Ferguson patent, I know of very little in the art thus far disclosed to anticipate properly any of the other reinforced-concrete patents now in controversy in the courts.

An illuminating parallel for reinforced concrete is the Grant rubber-tire patent held valid by the United States Supreme Court in 1911 (220 U. S., 428). The rubber tire for vehicle wheels is molded as a plastic and reinforced with two wires longitudinally to hold it to its seat between the two flanges of the felloe. The old forms known to the art had square or inclosing flanges to hold the tire from being dislodged. The new Grant tire had outwardly inclined flanges, permitting the tire to be unseated on striking a side obstruction, but relying on the two reinforcing wires to bring it back to place.

Does this represent any greater advance in the art than most of the patents on reinforced concrete that you have been criticizing? Suppose we attenuate an arch of molded plastic until tension occurs at either edge upon application of a live load and then reinforce each edge with steel bars to bring the arch back to place when deformed by such loads; is it not on all fours with the rubber tire? On the Supreme Court decision in the rubber-tire case the owners of the Grant patent took judgment for more than $600,000.

The opposition of the civil-engineering profession is not to paper patents, but to successful patents, to patents that have developed the art and that have proved effective in excluding others, which are the fundamental reasons for the patent system. The Cameron septic-process patent and the Warren bitulithic-pavement patent are examples; both of them have stood the final test of invention and validity.

Indianapolis, Feb. 9, 1917. DANIEL B. LUTEN.

The Future of Mattamuskeet

Sir—I have read with interest the articles and editorial notes in "Engineering News" of Mar. 1, relating to the drainage of Mattamuskeet Lake, in Hyde County, North Carolina. I think you did not sufficiently emphasize the fact that the plans are for the future and that this district does not show a project completed and in good shape. As I was over the project in an advisory capacity in February, I feel that I may well set forth the facts to date.

There is no doubt in my mind that the drainage project can and will be worked out to final success. The smooth level land is there, the rich soil is there, the difficulties to be encountered are not extremely unusual or insurmountable. The plans for drainage are well designed. The pumping plant is well constructed and capable of handling the water, as now, more rapidly than it can reach the plant; without going into the matter of calculations, I think it would be capable of discharging more than ½-in. rainfall per 24 hours from the whole tributary lands. Having spent two nights at the New Holland Inn, I have nothing but praise for its rooms, cuisine and management.

But it is apparent that the management of the district affairs has not been all that could be desired. There has been a delay of 17 months or more in completing the dredg-

ing, which does not seem warranted, although we must bear in mind the attendant circumstances, the difficulties of financing such operations, the long routes of transportation into the locality, etc.

The only work done in 17 months on canals or levees is that a "walking dredge" has been purchased to clean out the ditches, and it had gone some few hundred feet up the main canal from the pumping plant when I was down there. This machine was a 1- or 1½-yd. clamshell dipper dredge, operating on a turntable and "walking" along upon one berm of the ditch. It was not then operating as successfully as desired and, in my opinion, is not the best type of machine for this purpose.

The main outlet canal, main interior canals and laterals, such of them as I could see and examine within the three days at my disposal, are badly filled with silt. The main canals have been completed for about two years and in places have silted up as much as from 3 to 5 ft. The outlet canal, designed for navigation, having a bascule or lift bridge over it at one point, was so badly filled as to have only about 2 ft. depth of water at some places and, I was informed, was not navigable for coal barges, except under favorable conditions of wind and tide.

I noticed also that the canals are not all completed, nor yet all the boundary levees. In fact, on Feb. 6, 1917, there yet remained 485,518 cu.yd. of excavation to be made to complete the original contract, and through somebody's fault or blundering two small dipper dredges capable of completing the work in six or eight months were then lying idle and rusting out, and have been so for about 17 months past, while they ought to have been at work and the project completed. Also, the ditches have probably silted up more as a result of idleness and delay than they would have done if the work had been expedited.

Litigation on the work has been settled, and arrangements are said to have been made to go on with the dredging to completion and also for redredging such parts of the canals as have become badly silted. The need for redredging work so quickly after the original construction might lead one to doubt the feasibility of maintaining these ditches without great cost. But if the soil is as productive as I am led to believe it is from what I have seen of it, the owners will be justified in any reasonable expenditure of money for maintenance. In fact, in most of the river districts along the Mississippi and Illinois Rivers the same or similar conditions of siltage prevail, and it is found from actual experience that those lands are justified in spending as much as $20 to $30 per acre for the original construction and from $1 to $3 per acre per annum for maintenance. Also, experience has taught that, with a good recleaning of the ditches within four or five years after their original construction, the annual cost of maintenance and the need for redredging become less and less, due to the ditches assuming their natural slopes and permanent banks, and to other causes.

Further, as to soil and land values, I feel certain that the soils in Mattamuskeet Lake and vicinity are all that have been claimed for them. I saw samples of various crops grown upon a small experimental tract within the lake bed (leveed off by a dike not over 4 ft. high, with a small pump to care for the surplus water). These would be considered extremely good, even if grown upon the best farm lands of Illinois or Iowa. Among the crops thus grown were cotton stalks 7 ft. high, yellow dent corn with ears 10¾ in. long, white corn with ears nearly or quite a foot long, also a variety of prolific corn, one stalk of which bore five ears and many stalks of which had three ears, but of course not so large as those named.

Other crops observed and grown here were vegetables of a most luxurious kind—potatoes, sweet potatoes, yams, pumpkins and the like, looking as fine as you would see anywhere at a state-fair exhibit. Also, there was a great variety of grains, forage crops, etc. There is no question as to the fertility of that soil. It is similar to the silt soils upon all our great river valleys. The lands surrounding the lake have been in cultivation, some of them, for over 200 years and are still growing fine crops of cotton and corn wherever the land is a foot or two higher than mean tide. It is a curious fact that the highest lands around this lake seldom attain a height of 10 ft. above sea level, and the greater part of the county is less than 5 ft. above.

J. W. DAPPERT.

Taylorville, Ill., Mar. 6, 1917.

[In justice to the Mattamuskeet Drainage Commission, it should be stated that the responsibility for the delay in completing the ditches and levees does not superficially appear to rest entirely on the commissioners. There has been some litigation over priority of securities, and there seems to have been a lack of close coöperation with the dredging contractors. It may be inferred, from the harmony and dispatch with which the pumping station was completed (by another contractor) that some share of the blame may rest on the ditch contractor.—Editor.]

Advisability of Using Old Macadam as a Pavement Foundation

Sir—As Warren Brothers Co. and I personally have taken the initiative (beginning in Boston with the laying of bitulithic pavement on Dartmouth St. in 1903) on the positive affirmative side of this question, and as we have claimed and proved by long practical experience that old macadam forms a most superior foundation for a resilient and stable bituminous wearing surface, it seems proper that I should reply to the article in your issue of Feb. 1 by W. S. Anderson on this subject.

Mr. Anderson builds a "man of straw" and asks how to proceed when the width of new roadway exceeds the width of old macadam, a condition which very seldom arises. He then relates the dire consequences of cracks and paints a word picture of those fearful cracks along the line of the joint between the new and the old macadam base.

Mr. Anderson then proceeds to knock down his "man of straw" by saying, "To eliminate cracks, the subgrade must be made uniform in character by scarifying and loosening the old macadam foundation and by a uniform respreading and rolling of the excavated material over the subgrade. Such a procedure does not necessarily insure a uniformly compacted subgrade, but approaches it within practical limits."

Having worked himself on through a series of other direful objections to the economic salvage of millions of dollars already invested in macadam by utilizing it as foundations for new, stable, resilient bituminous surfaces, he takes more courage by way of advocating the economically unpractical rule, "the macadam should in all cases (of side fill more than a foot deep) be loosened or scarified to a depth of not less than one foot."

Mr. Anderson may be surprised when I suggest that if such a condition ever exists, just increase the width of the road by a foundation of new concrete, under which condition the undisturbed old macadam base in the old roadway will not settle and of course the new concrete base at the increased width at the sides will not settle and we will have the desired condition, a foundation which will not break up because of unequal settlement.

GEORGE C. WARREN.

Boston, Mass., Mar. 13, 1917.

Welding the Schenectady Pipe

Sir—I desire to present the following paragraphs as an accurate statement of conditions under which the welding of the Schenectady lock-bar pipe has to be done (as noted in "Engineering News," Mar. 1, 1917, p. 374) to correct some evident misunderstandings.

About half of the 10,000 ft. of this line is laid in swampy ground which is wet all the time, so that excavation cannot be eliminated as your report stated. I have walked over the entire line and inspected the pipe for some distance inside; I estimated that 15 joints would have to be welded inside (under highways, etc.). The remainder of the joints, in my judgment, could best be welded on the outside, since the pipe is coated inside as well as outside, to prevent rusting; and the fumes of this combustible material, together with the gases from any welding operation, will be difficult to remove in a 36-in. pipe with manholes 750 ft. apart. I believe it would be cheaper in the end to excavate around the joints—even if it should prove practical to weld in swampy locations without excavation.

The leakage test provided in the specifications is all right so far as it goes; but it does not locate leaks, and a small covered leak will rapidly cut a hole in the pipe.

The Rochester Welding Works made experimental welds on both inside and outside of this pipe; these were done under very unsatisfactory conditions, but showed the possibility of using the oxyacetylene process. My own experience in such work and in all kinds of oxyacetylene welding has been sufficient to enable me to bid without any fear that this contract could not be satisfactorily completed with this method. A far larger job was successful in 1910-11 at Boulder, Colo.; at the lower end of the pipe the sheet was 1⅜ in. thick and carried a pressure of 825 lb. per square inch.

Perhaps I ought to state out of fairness that the Schenectady Board of Contract and Supply had a representative of the General Electric Co., which employs both processes in its works, testify in the presence of bidders that a better job could be secured by inside welding electrically done.

S. W. MILLER.

Rochester Welding Works, Rochester, N. Y., Mar. 5, 1917.

New Columbia River Interstate Bridge Remarkable for Its Length

By Frank M. Cortelyou*

The Interstate Bridge over the Columbia River between Portland, Ore., and Vancouver, Wash., has a total length of about 23,000 ft., including all its approaches. At the Vancouver end approaches are provided on Washington St. and from Main St. by way of First St.; each approach is about 300 ft. long. The structure over the main channel of the river is 3530 ft. long, consisting of ten 265½ ft. truss spans, three 275 ft. truss spans, and one 50 ft. girder span. One of the 275 ft. spans is a vertical-lift draw which can be raised to give 150 ft. clearance above ordinary high water.

To the south of this bridge Hayden Island is crossed on an embankment 1480 ft. long, and the Oregon Slough by a plate-girder bridge 1110 ft. long, consisting of 11 spans. From the south side of Oregon Slough there are two approaches, one about 10,800 ft. long connecting to Union Ave., and the other about 5800 ft. long connecting to Derby St., Portland. These approaches are on embankments averaging about 24 ft. in height, with the exception of a four-span plate-girder bridge 307 ft. long over Columbia Slough in the Union Ave. approach.

*Resident Engineer for Harrington, Howard & Ash, Consulting Engineers, Kansas City, Mo.

FIG. 1. CHANNEL END OF INTERSTATE BRIDGE

The bridge provides a roadway 38 ft. wide from Vancouver to the south side of Oregon Slough. From this point to Portland a 30-ft. roadway is provided on the Union Ave. approach and an 18-ft. roadway on the Derby St. approach. On the steel portions there is also provided a sidewalk, 4½ ft. wide on the truss spans and 5½ ft. wide on the girder spans. Provision is also made for the future addition of a sidewalk on the approaches south of Oregon Slough.

Six lines of rail are provided on all the steel bridges, for double-track electric railways, both, standard- and narrow gage.

The Vancouver approaches contain 25,000 cu.yd. of sand, the embankment over Hayden Island 105,000 cu.yd., the Union Ave. approach 820,000 cu.yd. and the Derby St. approach 515,000 cu.yd., making a total of 1,465,000 cu.yd. in all embankments.

The piers for all three bridges are of the open crib type, resting on piles. The concrete in the pier bases fills in around and over the tops of the piles, being retained during its placing by timber cribs which are left permanently in place. The concrete pier shafts extend from a point well below low-water mark to above high-water mark.

About 23,000 cu.yd. of concrete, 1,800,000 ft. of timber and 222,000 lin.ft. of piling were used in the construction of the piers.

In the bridge over the Columbia River channel there are 6875 tons of structural steel, 310 tons of steel rails and 180 tons of machinery, cables, etc. In the bridges over the Oregon and Columbia Sloughs there are 1600 tons of structural steel and 130 tons of steel rails.

The deck of the steel bridges is fireproof throughout, no timber of any sort being used as part of the permanent construction. The sidewalk is a concrete slab spanning from the curb of the roadway to a channel stringer near its outer edge. The roadway is paved with bitulithic pavement supported on a concrete slab, with concrete headers along the six lines of rails.

The bridge was opened to traffic on Feb. 14, 1917. Its total cost, including all approaches, will be 1¾ million dollars. The contractors for the main parts of the work were: For foundations, Pacific Bridge Co.; for steel, United States Steel Products Co. and Northwest Steel Co.; for erection of steel, Porter Brothers; for embankments, Tacoma Dredging Co. and Standard American Dredging Co.; pavements, Warren Construction Co.

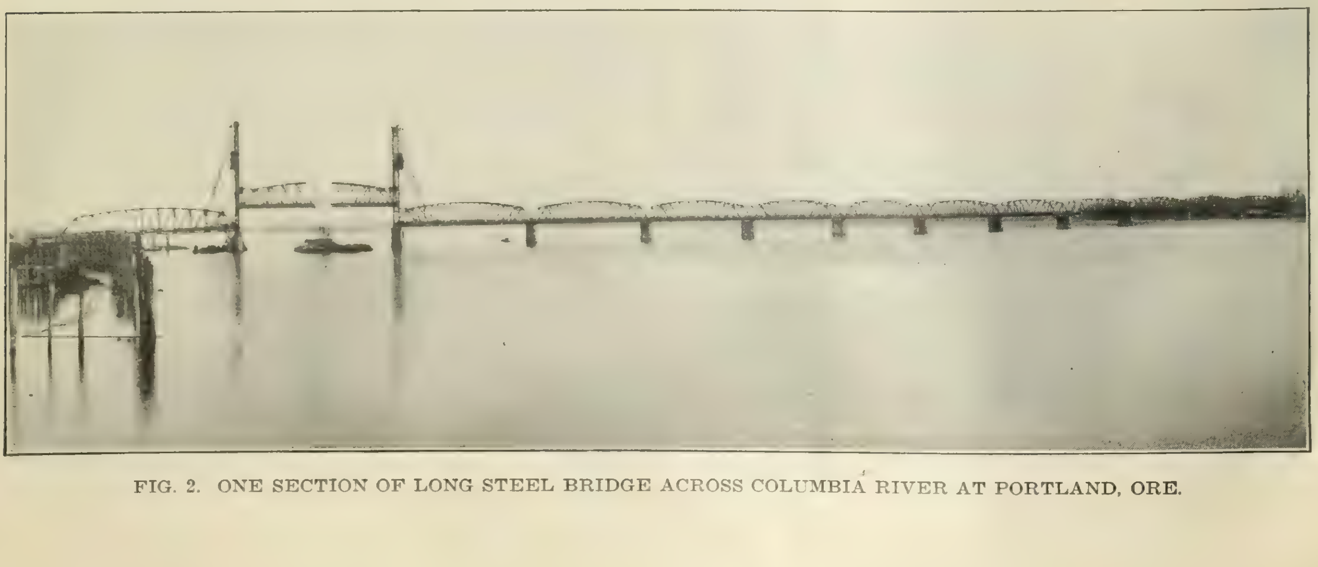


FIG. 2. ONE SECTION OF LONG STEEL BRIDGE ACROSS COLUMBIA RIVER AT PORTLAND, ORE.

Railway Engineers Meet at Chicago

The disposal of a large amount of work dealing with a variety of subjects relating to railway construction, fixed equipment and maintenance marked the 18th annual convention of the American Railway Engineering Association, held in Chicago, Mar. 20-22. Probably the two most important matters presented were the new "quick-bend test" for rails and a new impact formula for bridges, but neither was discussed, though the latter was adopted. The most active discussions were on the subjects of concrete piles, wood versus concrete trestles, and specifications for lumber.

The address of the President, A. S. Baldwin (Chief Engineer, Illinois Central R.R.) touched not only upon the technical side of railway work but upon the relation of the railways to the present national conditions and military requirements. The Association has now 1370 members, and shows an increase of 33% in five years. The officers for 1917 are as follows: President, John G. Sullivan, Chief Engineer, Canadian Pacific Ry. (Western Lines); Vice presidents, C. A. Morse, Chief Engineer, Chicago, Rock Island & Pacific Ry., and Earl Stimson, Engineer of Maintenance of Way, Baltimore & Ohio R.R.; Treasurer, George H. Bremner, District Engineer (Valuation Division), Interstate Commerce Commission; Secretary, E. H. Fritch, Chicago.

New Impact Formula

A new impact formula submitted by the Committee on Iron and Steel Structures was adopted without discussion. It does not cover provision for secondary stresses or increase of loading. The formula is as follows, L being the length of track loaded.

$$I = \frac{30{,}000}{30{,}000 + L^2}$$

Tests of impact stresses on bridges of the Norfolk & Western R.R. were reported by Professor Turneaure, of this committee. These are of special interest in comparing the effect of electric locomotives with that of ordinary and Mallet-duplex steam locomotives. They are the first tests made with electric locomotives. As cranks are used in these locomotives on this road improper balancing is a factor. It appears also that when the two sets of counterweights in a Mallet engine act in opposite directions the impact effect is even less than with electric locomotives.

Concrete and creosoted-pile trestles were compared by the Committee on Wooden Bridges and Trestles, the former being considered to have several advantages. In the discussion, however, it appeared that the report applied only to structures of 20 to 25 ft. in height, while several speakers described the satisfactory use of creosoted-pile trestles up to 60 ft. in height, using ballasted decks. Creosoted-pile trestles, properly protected against fire, may have a much longer life than is sometimes estimated. The committee finds that galvanized bolts and fastenings are not necessary in creosoted timber, and that such timber does not cause corrosion of steel upon which it rests.

Specifications for yellow-pine for preservative treatment, as submitted by the Committee on Grading of Lumber, required all timbers to be "dense pine." This was strongly opposed on the ground that while other classes of pine may have less strength that is no good reason for excluding them. In particular, Mr. Frink (Seaboard Air Line) referred to long and satisfactory experience with creosoted ballast-deck trestles of loblolly pine. The specifications were referred back to the committee.

Specifications for concrete piles (pre-cast and cast-in-place) were submitted by the Committee on Masonry. For driving the former, steam hammers are preferred, but where a drop hammer is used a heavy hammer with short drop is advocated. Professor Jacoby suggested that more should be said as to the relative advantages of the two kinds of piles, and also as to the desirability of exploring the site before deciding upon the kind of piles to be used. The specifications were referred back to the committee. Specifications for different methods of surface finish for concrete were presented also, and were adopted.

As to the design of retaining walls, the committee believes that further investigation of earth pressures should be made, and that results of real value can be obtained only by actual tests on an extensive scale.

The committee's specifications for portland and natural cement were adopted.

Rail Quality and Stresses

The proposed "quick-bend" or hydraulic-press test for rails was treated at some length in the report of the Committee on Rail, but was not discussed, the matter being submitted only as information. The report stated also that while the rail manufacturers have made some objection to the A. R. E. A. rail-sections they have submitted no data in support of their views. They have urged also that rails are now being made as well as they can be made commercially, but a report on rail failures by Mr. Wickhorst intimates that it is practicable to reduce the number and kind of rail failures to a point where the probability of accident from a broken rail is almost negligible. This view was supported in a report by Mr. Cushing (Pennsylvania Lines) which stated that while railways have introduced rails of increased weight, strength and stiffness, these changes have not been accompanied by a corresponding improvement in the quality of the material. In this connection he advocated casting ingots with the large end up.

Field tests of stresses in rails in track under rapidly moving loads are being made by the Committee on Stresses in Track, which is also conducting tests to determine the distribution of pressure downward and laterally through ballast to the roadbed. Progress was reported by Professor Talbot (University of Illinois), who also suggested that instead of considering the rail as a series of bridges spanning from tie to tie, the span should be considered rather as the distance between driving wheels.

Signals, Yards and Clearances

An analysis of the effect of passing-track locations with manual and automatic signals on the capacity of single-track roads was a feature of the report of the Committee on Signaling and Interlocking. The analysis was made with the aid of diagrams and formulas, and is of somewhat the same character as the analysis of train capacity of passenger terminals, which was worked out some time ago by the Committee on Yards and Terminals.

The latter committee presented a set of profiles for the "humps" of gravity classification yards in cold, mild and warm climates, where the traffic consists of merchandise and empties. These were adopted. The report pointed out, however, that they are suggestive only, as the actual hump profile for any yard must depend upon local conditions of climate, traffic and classification requirements. The committee submitted a number of types of ladders for the track connections of small and large yards. Two subjects of interest in regard to freight terminals were the economics of double-deck freight houses and the use of small motor trucks to haul trains of freighthouse or warehouse trucks.

Clearance limits and diagrams were the subject of considerable discussion at the 1916 meeting. This year the Committee on Electricity submitted clearance diagrams for third-rail and overhead structures, which were accepted as information. The Committee on Rules and Organization submitted a general clearance diagram, to apply to new construction only. This (as modified from the 1916 diagram) has a minimum width of 15 ft. for 12 ft. above a point 4½ ft. above base of rail. It tapers to a horizontal width of 8 ft. at 22½ ft. and 10 ft. at 8½ in. above rail base. Mr. Himes (N. Y., C. & St. L. Ry.) objected to cutting off the lower corners, and urged that the horizontal clearance of 15 ft. should extend down to rail level. After some discussion, however, the diagram as recommended by the committee was adopted.

The Committee on Economics of Railway Location suggested the elimination of formulas previously adopted for determining the comparative values of different locations, but as there was opposition to this, even in the committee, the matter was referred back for further consideration.

Roadway and Track

Plant and methods of work in making cuts and fills were dealt with in the report of the Committee on Roadway, giving the opinions of both engineers and contractors. That there is a growing feeling in favor of a more substantial foundation for the track is indicated by the fact that the committee reported on the rolling of subgrade, as practiced experimentally on two or three roads, while the Committee on Ballast advocated a considerable increase in quantity, including a bed of sub-ballast to prevent roadbed material from working up into the ballast proper. It advocates not less than 12 in. of ballast between the ties and sub-ballast.

As to washed gravel, experiments indicate that instead of requiring 25 to 35% of sand, it is improved by reducing this to about 7%. There was some discussion as to the relative merits of stone and gravel ballast, for while the former is generally considered the better, some grades of gravel are preferred to stone. The committee's proposed standard ballast sections were referred back to it for further consideration. A testing track for maintenance-of-way work was suggested, this to consist of a loop on which various kinds of track material could be tested by running over it for any desired length of time an electric car having the required axle loads, this car being controlled from a cabin.

That tie-plates have insufficient area and thickness for the increasing wheel loads was a conclusion presented by the Committee on Ties. Indications point to the use of much heavier tie-plates. It was stated also that cut spikes driven without boring holes not only hasten decay but also impair the strength of ties by the injury to the fibers. Screw spikes are less destructive. Tie-plates and spikes were considered also by the Committee on Track, whose designs for both cut and screw spikes were adopted. Experiments are being made as to the effect of brine from cars in corroding tie-plates coated with paint and tar as compared with those left unprotected.

As of interest in regard to tie preservation, the committee on Wood Preservation submitted notes on ties treated with a 10-lb. application of water-gas tar-oil, and now in good condition after four to six years' service.

Elimination of Grade Crossings

The elimination of grade crossings was dealt with in two reports. The Committee on Signs, Fences and Crossings considered the legal aspects and the apportionment of cost, while the Committee on Roadway considered the relative merits of track elevation and depression. The former committee gave favorable reports on steel and concrete fence posts. It advocated the elimination of lettering on track signs, so that these can be painted by section men. This recommendation was rejected, however, as it was shown that there is a tendency to put all kinds of miscellaneous work on the section men, while their real duty is to look after the track.

The introduction of electric traction (whether by third-rail or overhead conductor) increases the cost of maintenance-of-way according to the Committee on Electricity. This is due partly to the obstruction (in case of the third rail) and partly to the fear and caution of the men in their work. This committee also submitted the lengthy preliminary report of the American Committee on Electrolysis.

Kansas City Railway-Station Approaches To Be Improved

Two plans for improving and enlarging the approaches to the new union station at Kansas City, Mo., were submitted to vote of the people at the same time they voted down the proposed new charter, Mar. 6. The so-called larger plan carried by a vote of two to one. This calls for the condemnation of all the privately owned land between the railway tracks and 24th St. and between Main St. and Grand Ave., east of the station, and widens 24th St. west of the station to 80 ft. The smaller plan provided for widening 23d St. and 24th St. to give adequate traffic approaches.

The larger plan, which will now be carried into effect, is estimated to cost close to $2,000,000, practically double the estimated cost of the smaller plan. Bonds for $750,000 were voted for this project in 1915, but a dispute arose as to the extent of the improvement, and the alternative plans were therefore submitted for a decision. The excess cost over the amount of bonds will be assessed over a special benefit district.

Facing the station on the south is already an 8½-acre park and a plaza 400 ft. wide, so that, with the proposed parked approaches to the east and west, there are many who believe that the congestion and unsightly conditions that surround so many terminal stations have been definitely eliminated. There are no valuable buildings on any of the land to be condemned.

News of the Engineering World

One Hundred and One Officers Added to Army Engineer Reserve Corps

A list of majors and captains who had accepted commissions in the Engineer Officers Reserve Corps of the Army, up to Feb. 15, was printed in *Engineering News*, Mar. 1, p. 369. Since then the total number of officers has risen from 71 to 172. Following is a list of added majors and captains and the complete list of first lieutenants:

MAJORS ADDED

S. H. Hedges, M. Am. Soc. C. E., President, Puget Sound Bridge and Dredging Co., Seattle.
Ruckard Hurd, M. Am. Inst. M. E., Director of Mines, Minnesota Tax Commission, St. Paul.
Paul Doty, M. Am. Inst. E. E., General Manager, St. Paul Gas Light Co., St. Paul, Minn.
W. L. Webb, M. Am. Soc. C. E., Consulting Engineer, Philadelphia.
J. B. Jenkins, Valuation Department, Baltimore & Ohio R.R., Baltimore, Md.
W. J. Wilgus, M. Am. Soc. C. E., Consulting Engineer, New York City.
W. H. Herron, United States Geological Survey, Washington, D. C.
R. B. Marshall, M. Am. Soc. C. E., Chief Geographer, United States Geological Survey, Washington, D. C.
A. C. Harper, United States Engineer Office, Albany, N. Y.
F. J. Wood, M. Am. Soc. C. E., Stone & Webster, Boston, Mass.
G. E. Verrill, M. Am. Soc. C. E., United States Assistant Engineer, New London, Conn.
F. W. LaForge, M. Am. Soc. C. E., Fort Wright, New London, Conn.
W. B. Harrison, M. Am. Soc. C. E., United States Assistant Engineer, Washington, D. C.
A. M. Walker, United States Geological Survey, Washington, D. C.
J. H. Jennings, United States Geological Survey, Washington, D. C.
G. T. Hawkins, United States Geological Survey, Washington, D. C.
F. I. Wheeler, United States Engineer Office, Cleveland, Ohio.

CAPTAINS ADDED

J. S. Doyle, M. Am. Soc. C. E., Baltimore.
E. A. Gibbs, Assoc. M. Am. Soc. C. E., Manager of Erection, McClintic-Marshall Co, Pittsburgh.
A. H. Pratt, M. Am. Soc. C. E., Assistant Engineer, Board of Estimate, New York City.
E. B. Murray, Assoc. M. Am. Soc. C. E., Consulting Engineer, Kansas City
W. O. Washington, Assoc. M. Am. Soc. C. E., Contracting Engineer, San Antonio, Tex.
A. Stellhorn, Assoc. M. Am. Soc. C. E., Civil Engineer, U. S. Q. M. Corps, Gatun, C. Z.
J. S. Herbert, M. Am. Soc. M. E., Johnstown, Penn.
W. D. Peaslee, M. Am. Inst. E. E., Consulting Engineer, Portland, Ore.
J. W. Skelly, M. Am. Soc. C. E., United States Assistant Engineer, St. Louis.
H. W. Hudson, M. Am. Soc. C. E., Engineer of Construction, New York Connecting Ry., New York City.
J. D. Irving, M. Am. Inst. M. E., Sheffield Scientific School, New Haven, Conn.
A. B. Searle, United States Geological Survey, Washington, D. C.
E. H. Ropes, Assoc. M. Am. Soc. C. E., Civil Engineer, United States Coast Guard, Washington, D. C.
E. B. Butchers, Assoc. M. Am. Soc. C. E., American Bridge Co., Ambridge, Penn.
F. W. Green, St. Louis, Mo.
W. L. Miller, United States Geological Survey, Washington, D. C.
H. J. Stehli, M. Am. Inst. M. E., Mining Engineer, New York City.
J. F. Barber, Philadelphia.
C. B. Stanton, Carnegie Institute, Pittsburgh.
R. B. H. Begg, Assoc. M. Am. Soc. C. E., Virginia Polytechnic Institute, Blacksburg.
C. T. Osborne, St. Louis, Mo.
H. V. Pittman, United States Engineer Office, St. Louis, Mo.
C. C. Elmer, Ridley Park, Penn.
M. W. Smith, American Steel Foundries, Chicago.
P. J. Wilson, M. Am. Inst. E. E., Lowell Electric Light Corporation, Lowell, Mass.
F. E. Foster, St. Louis, Mo.
G. T. Street, M. Am. Inst. E. E., Youngstown, Ohio.

COMPLETE LIST OF FIRST LIEUTENANTS

C. W. Wilder, New York City.
J. M. Marshall, Brooklyn, N. Y.
Walter M. Meir, Bartlesville, Okla.
William Burton, Montclair, N. J.
H. B. Barling, Glendon, N. C.
S. H. Sherrerd, East Orange, N. J.
D. W. Krellwitz, New York City.
F. C. Allen, 3rd, Milwaukee, Wis.
William Hague, Grass Valley, Calif.
A. C. Forbes, Brooklyn, N. Y.
M. R. Scharff, Pittsburgh, Penn.
C. L. Harrod, Altoona, Penn.
L. C. Waterbury, Oriskany, N. Y.
K. J. Zinck, Portland, Ore.
Edward B. Snell, New York City.
H. H. George, Newark, N. J.
John Leo Desch, Maplewood, N. J.
M. T. Coakley, Buffalo, N. Y.
R. J. O'Brien, New York City.
Harry T. Griswold, Lyme, Conn.
G. A. Schneider, Hammond, Ind.
J. Schlessinger, Baltimore, Md.
E. K. Carley, East Orange, N. J.
E. P. Gray, Toledo, Ohio.
Walter H. Dunlap, Washington, D. C.
A. F. Edel, New York City.
Hugo C. Soest, New York City.
James F. C. Hyde, Detroit, Mich.
J. R. Wemlinger, New York City.
Henry Taylor, Philadelphia, Penn.
L. C. Josephs, Jr., Schenectady, N. Y.
E. L. Bandy, Washington, D. C.
Robert Boettger, Yonkers, N.Y.
Warren Gardner, New York City.
T. C. Thogerson, St. Louis, Mo.
H. L. Haverstick, Philadelphia, Penn.
L. S. Leopold, Pottstown, Penn.
S. Steenerson, Crookston, Minn.
John R. Eakin, Washington, D. C.
Luria L. Lee, Washington, D. C.
R. B. Carver, New York City.
E. L. Hain, Washington, D. C.
Harry V. Newcomb, Cape Girardeau, Mo.
Frank W. Hamilton, Groton, Conn.
John E. Terhune, Albany, N. Y.
Evan W. Scott, E. Roanoke, Va.
James F. Ryder, Watertown, Mass.
A. S. Mirick, Plattsburg, N. Y.
E. D. Hendricks, Fort Plain, N. Y.
T. H. Moncure, Washington, D. C.
Seth W. Webb, Cleveland, Ohio.
Samuel H. Brooks, Wakefield, Mass.
Frank T. Leilich, Swissvale, Penn.
Gordon H. Fernald, Somerville, Mass.
B. D. Barker, Chicago, Ill.
F. Miller, Lynn, Mass.
Theodore Belzner, New York City.
A. E. Crane, Plainfield, N. J.
F. N. Wildish, Chicago, Ill.
R. W. Queal, Kansas City, Mo.
John G. Kelly, Jr., Portland, Ore.
Robert W. McLean, Bridgewater, Mass.
Louis N. Sperry, Utica, N. Y.
A. D. Stoddard, Kansas City, Mo.
J. R. Armington, Ambridge, Penn.
Alexander A. Laird, Dallas, Tex.

Pittsburgh Bridges Ordered Raised

The fourteen-year fight of the river interests against the users and owners of the bridges over the Allegheny River at Pittsburgh ended with victory when Secretary of War Baker, on Mar. 23, handed down an order that the bridges should be raised, and as the power bestowed on the Secretary of War by the Act of Congress of March, 1899, to order removed any bridges which he shall find

to be "unreasonable obstructions to navigation" has been tested and sustained previously before the Supreme Court, there seems to be little hope for the opponents of bridge raising. The river men, reinforced by the recommendations of every U. S. Engineer officer stationed in succession at Pittsburgh, have reopened their case with each succeeding Secretary of War. The owners have urged in vain that the case once decided in their favor by Secretary of War Root should be allowed to rest, but at the rehearings before Secretaries Dickinson and Taft were successful in persuading them that no new facts had arisen to alter the conditions on which Secretary Root based his decision. Mr. Baker feels otherwise, and after studying the facts brought out in a hearing in Pittsburgh in January-February of 1916 and subsequent reports of the U. S. Engineers has decided:

The bridges in question are unreasonable obstruction to the navigation of the Allegheny River.

Their immediate elevation and the relocation of their piers is necessary in the national interest.

These improvements ought to be undertaken in such an order as to make the inconvenience to the people of Pittsburgh during their progress the least possible.

Six of the bridges affected are owned by Allegheny County, but 75% to 80% of the burden of reconstruction would fall on the taxpayers of the city of Pittsburgh. The actual cost of the rebuilding is estimated at $3,600,000, and it was testified by the city's representatives at the hearings that the damages incident to changes of the approaches of the bridges would be $4,651,000. Up to a few years ago most of the bridges were owned by toll companies; the county acquired them at a cost of $2,530,000.

The Sixth, Seventh and Ninth St. bridges would be raised 7 to 9 ft. the Thirtieth St. bridge 3 ft. The Sixteenth and Forty-Third St. bridges, wooden Howe-truss structures with stiffening arches, are required to be rebuilt 12 and 15 ft. higher. The requirements for pier location and channel span of not less than 350 ft. will make the re-use of any of the present bridges impossible.

The other bridge affected by the order is the double-deck four-track structure of the Pennsylvania Lines West of Pittsburgh. At the time of its construction the railroad was required to agree to raise the spans at such time as the raising of the other bridges was ordered. The Pittsburgh Junction bridge of the Baltimore and Ohio R.R. at Thirtieth St. has already been planned to be rebuilt at a higher elevation, to connect with the track elevation over Liberty St., Pittsburgh.

Flood Control and Land Reclamation Helped by Court Decision

On Mar. 14 the Supreme Court of California rendered a decision which is of great importance as affecting flood control in the Sacramento and San Joaquin Valleys. In this decision the Supreme Court reversed the decision of the Superior Court of Sutter County (Sam Gray, et al. vs. Reclamation District No. 1500) which had granted an injunction restraining that district (the Sutter Basin project) from constructing certain levees which would raise the flood plane in the vicinity of the plaintiff's land and at times cause it to be overflowed.

The effect of this decision in California, aside from permitting District No. 1500 to continue the construction of its levees, is to uphold the powers of the State Reclamation Board and the plan of flood control for the Sacramento Valley as outlined in the report of the California Debris Commission of 1910 (House Document No. 81, 62nd Congress, 1st Session), which plan was adopted by the State of California and the Reclamation Board formed to carry it into execution.

The decision may also be of interest to others who have to do with flood control, as in the Ohio and Mississippi Valleys, as it very clearly and definitely gives the principles upon which the decision is based, particularly those relative to the police powers of the state, and the relation of surface waters to flood waters in time of flood.—From R. L. Jones, Sacramento, Calif.

Kansas To Have Highway Commission

A State Highway Commission has been created in Kansas by an act approved on Feb. 28. The commission is to be made up of the governor, ex officio, as chairman, and two members to be appointed by him. The appointed members are to receive as compensation $5 per day for time actually spent, but not to exceed a total of $200 per year, plus their necessary traveling expenses. The commission is to appoint a secretary and chief engineer and fix their salaries. The commission is to have general supervision over the construction and maintenance of all roads, bridges and culverts, except township roads, and shall furnish information to town commissioners, county engineers and other highway officials.

Each board of county commissioners is required to appoint a competent county engineer, who is to prepare plans, specifications and estimates for roads, bridges and culverts built by the county. Two or more counties may unite, however, and employ a county engineer jointly. The salaries of county engineers are fixed according to the population of the county, ranging from $1300 per annum in counties with 10,000 to 15,000 population to $2000 per annum in counties having more than 30,000.

River Straightening at Cleveland is again actively under discussion. The present motive is the difficulty of locating piers for the proposed Lorain-Huron bridge across the valley of the Cuyahoga River without resorting to excessive span lengths; the river now makes a sharp bend in the vicinity of the proposed bridge crossing, and the bridge as laid out by law runs along one bank for a distance and then crosses on a sharp skew. The $5,000,000 authorized by popular vote for the construction of the bridge is considered to be practically unavailable until the bend of the river has been replaced by a straight cut.

Los Angeles Continues To Grow in Area by the annexation of territory. On Feb. 26, Owensmouth was annexed by popular vote. It had an area of less than a square mile and brings the total area of the city up to 338.69 sq.mi. Owensmouth was already surrounded by Los Angeles as a result of a recent annexation. It has just been brought into the City of Los Angeles in order to get the benefit of aqueduct water. On Apr. 6, an election will be held for the annexation of more "shoe-string" territory, comprising a narrow strip of ocean front at and near Hyperion, the terminus of the Los Angeles sewer-outfall system, and also a strip of land running from Hyperion back to Los Angeles.

The Electrification of the main line of the Pennsylvania R.R. across the Allegheny Mountains, between Altoona and Conemaugh, has been planned for some time by the Pennsylvania R.R. officials. President Rea in his recent annual report stated that the only work done during the year on the project was the continuation of detail surveys, the designing and construction of the type of electric locomotives required, and obtaining the experience of other railways in the use of electric traction for heavy freight and passenger trains. He intimated that the carrying out of the improvement would be postponed until the present period of high cost of construction material and scarcity of labor had passed.

Indiana Has a State Highway Commission, created on Mar. 6, composed of four members appointed by the Governor. The salary is $600 a year each. The Commission is to select the state highway engineer and to fix his salary, but in no case shall the overhead expense exceed $50,000 a year. The state money for the Highway Commission's work is to include $100,000 from the general state fund this year and $500,000 in 1918, to which will be added the inheritance tax collected annually by the state, approximating $400,000. In addition to this money the United States Government will add an equal amount up to and including the year 1920.

PERSONALS

J. R. Ellis has been appointed Assistant Engineer, State Highway Department of Missouri.

J. P. Davis has been appointed Assistant Engineer, State Highway Department of Missouri.

W. A. Freret has opened offices as a contracting engineer in Windsor, Colo. He will specialize in drainage and tile work.

David A. Decker, for the past six years Assistant City Engineer of Norfolk, Va., has resigned to become associated with Gilbert C. White, consulting engineer, Durham, N. C.

L. D. Lea, former City Engineer of Lead, S. D., has resigned to become Chief Engineer in charge of the Engineering Department of the Export Service Corporation, Chicago.

Oscar F. Dalstrom has been appointed Engineer of Bridges of the Chicago & Northwestern Railway Co. Mr. Dalstrom was graduated from Rensselaer in 1901 and has been with the railway several years.

G. N. Toops, Assoc. M. Am. Soc. C. E., formerly Assistant Engineer with the Missouri, Oklahoma & Gulf Railway Co., has been appointed Engineer of Maintenance-of-Way, with offices at Muskogee, Okla.

C. S. Bilyeu, Assoc. M. Am. Soc. C. E., formerly with Hildreth & Co., engineers, New York City, has become associated with the Gulick-Henderson organization of inspecting engineers, New York City.

Harry J. Childs has resigned as Chief Engineer of Power and Lines of the United Traction Co. of Albany, N. Y., to become head of the electrical department of the Chateaugay Ore and Iron Co., Lyon Mountain, N. Y.

Herbert A. Meyer, for four years Private Secretary to Franklin K. Lane, Secretary of the Interior, has been appointed Assistant Secretary of the Interior. He will have administrative charge of the Alaskan Ry. Mr. Meyer is 30 years old and a native of Ohio.

Ernest S. Alderman, Jun. Am. Soc. C. E., formerly United States Junior Highway Engineer, Department of Agriculture, Washington, D. C., has been appointed Supervising Engineer on the expenditure of a $500,000 bond issue passed by Beauregard Parish, De Ridder, La.

Howard F. Weiss, whose resignation as Director of the Forest Products Laboratory of the United States Forest Service takes effect Apr. 1, has become associated with the C. F. Burgess Laboratories, Madison, Wis. Mr. Weiss will direct the division relating to wood products.

Hugh L. Conway, for the past three years Principal Assistant Engineer in charge of the Street and Sewer Division, Cincinnati, has resigned to become General Manager of the Citizens' Road Preserving Co. Mr. Conway was graduated from the Ohio State University in 1896.

E. D. Kilburn, Assoc. Am. Inst. E. E., formerly Manager of the Power Department of the New York office of the Westinghouse Electric and Manufacturing Co., has been appointed District Manager, to succeeed W. S. Rugg, whose change of service is noted elsewhere in this column.

W. S. Rugg, M. Am. Inst. E. E., formerly District Manager of the New York office of the Westinghouse Electric and Manufacturing Co., succeeds Charles S. Cook as Manager of the Railway Department, with headquarters in East Pittsburgh. Mr. Rugg was born in Broadhead, Wis., and is a graduate of Cornell.

A. W. Graham, formerly Chief Executive Officer of the Park Department of Kansas City, Mo., has been appointed State Highway Engineer of Missouri. After graduation from the Missouri University in 1908, Mr. Graham went with Waddell & Harrington, and later was Assistant County Engineer of Jackson County.

H. S. Slocum has joined the Engineering Department of the Aluminum Company of America and will be resident engineer in charge of construction at Potsdam, N. Y. Mr. Slocum was resident engineer for the Cedars Rapids Power and Manufacturing Co. during the construction of the large Cedars development near Montreal. He was then in charge of construction for the Northern New York Power Corporation, and more recently represented the Shawinigan Water and Power Co. as resident engineer during the completion of the Grand' Mere development of the Laurenticle Power Co., after the Shawinigan company acquired an interest in the Laurentide concern. In earlier years he had been associated with Viele, Blackwell & Buck on the Great Western and Appalachian hydro-electric projects.

OBITUARY

James E. Gardner, City Engineer of Napa, Calif., died recently in Oakland.

John C. Wills, a mechanical engineer, died in Detroit on Mar. 16, at the age of 81 years.

R. J. Maloney, engineer in the Bureau of Sewers, New York City, died in Brooklyn, N. Y., on Mar. 19.

Robert J. Gillespie, Vice President of the T. A. Gillespie Co., New York City, died in Millvale, Penn., on Mar. 20, at the age of 47 years.

William H. Rogers, a consulting engineer, died at his home in Philadelphia recently, at the age of 78 years. He was formerly Superintendent of the Cramps' shipyard.

John Bacon Wood, a retired dock builder, died at his home in Brooklyn, N. Y., on Mar. 20, at the age of 90. His largest contract is said to have been the docks, basin and bridge of the Gowanus Canal, Brooklyn.

John Kasson Howe, Director and Eastern sales representative of the Osgood Co., Marion, Ohio, died at his home in Albany, N. Y., on Mar. 4, from angina pectoris. He organized the Osgood Dredge Co. in 1883, which company obtained the original patents on the boom-type dredge. He served as Secretary and Treasurer of that concern until its consolidation with the Osgood Co.

Daniel Wheeler Bowman, M. Am. Soc. C. E., consulting engineer for the Phœnix Iron Co., died on Mar. 13. He was born in New Bedford, Mass., in 1844, and was graduated in civil engineering from Cornell University. His first work was with Capt. James B. Eads at the mouth of the Mississippi River, directly under Elmer L. Corthel, late president of the American Society of Civil Engineers. In 1876 he became connected with Clarke-Reeves & Co., now the Phœnix Bridge Co., resigning in 1885 to go to Florida on the inspection of bridges for the Southern Railway Co. For a short time he was connected with the Boston Bridge Works, but in 1894 returned to Phœnixville in the engineering office of the Phœnix Iron Co., under H. H. Quimby, then chief engineer. About 1896 he resigned from the Phœnix Iron Co. and entered into the structural fabricating business in Chicago, returning to the Phœnix Iron Co. in 1898, and becoming Chief Engineer two years later. In 1914 he resigned and was made Consulting Engineer, in which office he continued until the time of his death.

ENGINEERING SOCIETIES

ST. LOUIS RAILWAY CLUB.
Apr. 13. Secy., B. W. Frauenthal, Union Station, St. Louis.

DETROIT ENGINEERING SOCIETY.
Apr. 21. Secy., D. V. Williamson, 46 Grand River Ave., W., Detroit.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
Apr. 26-28. In Dallas. Secy., H. S. Cooper, 405 Slaughter Building, Dallas, Tex.

The Astoria (Ore.) Society of Engineers was organized recently in that city with 12 members. The new organization will be affiliated with the Oregon Society of Engineers. The officers are: President, A. C. Rose; secretary, W. A. Hanston.

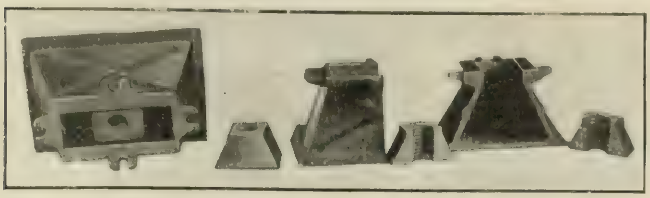
The National Association of Manufacturers will hold a meeting on Thursday, Mar. 29, at 2 p.m., at the Waldorf-Astoria. The subject of the meeting will be "Chile as a Field for Manufacturers and Investors," by the Hon. José A. Del Campo F., official delegate of the Chilean Government.

The American Society of Mechanical Engineers will hold its spring meeting in Cincinnati, May 21 to 24. A feature will be a joint session on May 22 with the National Machine Tool Builders' Association, at which papers will be presented on employees' service work and industrial education as developed in Cincinnati

Appliances and Materials

Support Inserts for Concrete Work

An adjustable insert, providing support or fastening for machinery or fixtures in concrete, has recently been marketed by the Medina Machine Co., of Medina, Ohio. It has the form of a truncated pyramidal box with ears on the face for nailing to forms and holding in place during pouring. The device is shown assembled and broken in the accompanying view. For final use a special nut is slipped in edgewise and tipped over. Nuts are easily removed. A solid insert of similar shape is also made by the same concern.



MEDINA INSERTS FOR FASTENING MACHINERY TO CONCRETE WORK

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Patented Asphalt-Sand Pavement, "Bitosan"

Patents have been issued, and others are pending, covering a method of constructing a sand-asphalt pavement, which it is claimed has been used with success in Falmouth, Mass. The new type of pavement is known by the trade name of "Bitosan," and the patents are controlled by the United States Asphalt Refining Co., 90 West St., New York City.

The Bitosan pavement consists of two (or sometimes three) courses. The foundation course, or base, is a hot mixture of Bitosan asphaltic cement and mineral aggregate of sand or gravel. The second, or wearing course, is a properly graded sand aggregate and a special asphaltic mastic or filler consisting of "Bitosan surface asphalt" and a finely pulverized material incorporated with it.

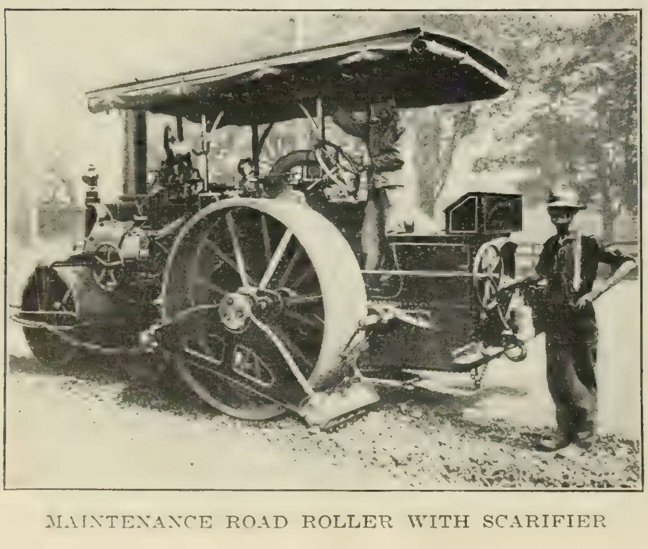
After the foundation course is laid, it is immediately compressed with a tandem roller and then protected from dust and sand by a covering. After the base is roughened, the wearing surface is immediately added and rolled. The sand to be used in construction must be analyzed and passed upon by a laboratory maintained by the patentees.

* * *

Maintenance Road Roller with Scarifier

A type of small three-wheel steam roller, known as a maintenance roller, has been introduced into this country from England, where it has been in successful use for a number of years. The distinctive feature of this maintenance roller is the scarifier attachment on one of the rear driving wheels. This is in the form of a yoke, as shown in the accompanying illustration, which can be tipped to make the teeth, or prongs, dig into the roadway, while traveling in either direction.

It is claimed that this attachment will loosen and break up water-bound macadam that has been treated with heavy oil and has a thick crust. It has been used for this purpose by several New England cities, and two of these rollers are now owned by the Massachusetts State Highway Commission. One of them was exhibited at the recent Good Roads Show in Mechanics Hall, Boston. The rollers are made by the Buffalo Springfield Roller Co., Springfield, Ohio.



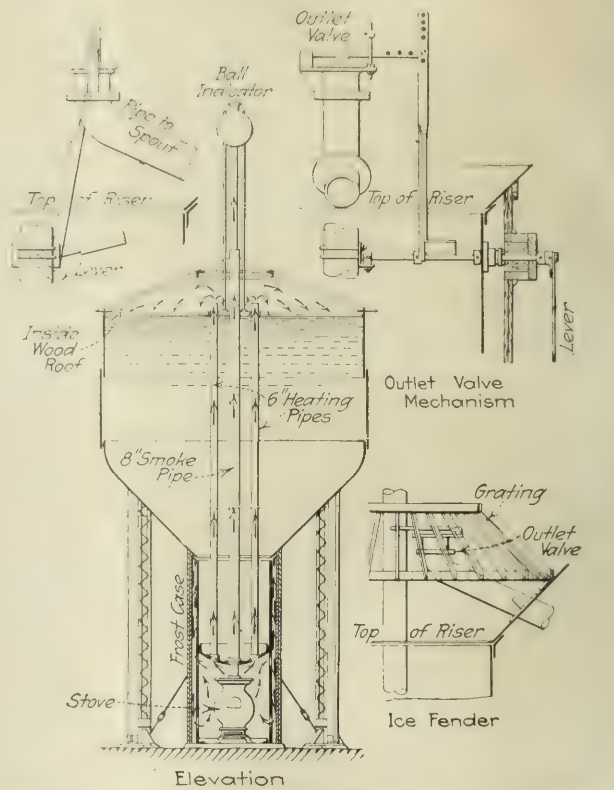
MAINTENANCE ROAD ROLLER WITH SCARIFIER

* * *

Heated Water Tanks for Railways in Cold Climates

The heated tank for railway water stations, shown in the accompanying drawing, is being designed for districts where very low temperatures are experienced and where water from ice-cold rivers is delivered to the tank. It is known as the "Canadian special" type and is built by the Chicago Bridge and Iron Works, of Chicago.

To prevent accumulation of ice inside the tank, a heating chamber is provided under the 6-ft. riser pipe, by raising the riser about 7 ft., giving ample room for a stove. The smoke and gases are carried off by an 8-in. wrought-iron pipe extending through the tank and roof. A 5-in. air space is formed by a frost casing built of two layers of dressed and matched lumber, with building paper between them. In this space circulates hot air from the chamber, and in this way the entire height of the riser is warmed. Heated air from the chamber is delivered also into the top of the tank by means of 6-in. wrought-iron pipe extending above the water line, thus preventing the formation of surface ice. A wood roof inside the steel roof assists in retaining the heat in the space above the water. No trouble from corrosion of the wrought-iron smoke pipe has been found. To avoid the ice troubles experienced with valves operated by overhead levers, the valve is operated from below by mechanism which is contained within the riser. The heating pipes are placed as closely as possible to the outlet valve and its operating mechanism. A fender or conical grating is placed above the top of the riser, so that even if the water is allowed to get low in the tank, ice cannot clog or damage the valve mechanism. The valve cap is cast solid, and the annular recess for the rubber seat is machined, thus getting a tighter fit than when the recess is cored in the casting.



HEATED TANK FOR RAILWAY WATER STATIONS

* * *

India Ink Solvent

A fluid for cleaning drawing ink from tracing cloth, with the trade name "Rasindia," is being made by Anderson & Furman, 110 West 40th St., New York City. It is claimed that it leaves no trace of the ink and does not affect the tracing cloth. It is rubbed on with a saturated cloth.